Institute for the Quantitative Study of Inclusion, Diversity, and Equity (QSIDE)

Chad M. Topaz, Maria-Veronica Ciocanel, Phoebe Cohen, Miles Ott, and Nancy Rodríguez

Introduction to QSIDE

Consider the following vital questions: *Are Black and Latinx artists represented proportionally in US museums? Why are some professional fields dominated by men and others by women? How can judges achieve equitable outcomes for defendants?* The mathematical sciences have the potential to address these questions at a level of detail undreamt of a decade ago. The Institute for the Quantitative Study of Inclusion, Diversity, and Equity, Inc. (QSIDE) brings quantitative expertise together with expertise from the social sciences, humanities, and arts to discover the impact and scope of injustices, and to build solutions to remedy them.

Established as an independent nonprofit 501(c)3 corporation in 2019, QSIDE is a multi-institutional network of scholars and practitioners. Our vision is inspired by civil rights leaders such as educator and investigative journalist Ida B. Wells, who said that “the way to right wrongs is to

shine the light of truth upon them.” For QSIDE, quantitative methods are one form of this light of truth. QSIDE has a four-pronged approach to achieving our vision. First, we incubate and conduct cross-disciplinary research that leverages quantitative tools. Second, we partner with people and organizations empowered to use our discoveries. Third, we build community among researchers and practitioners working on social justice issues through virtual and in-person networking and events. Finally, we increase capacity for work aligned with our vision by equipping those researchers and practitioners with appropriate methodologies and tools.

With this communication, we are reaching out to the mathematical sciences community. Our goal is to emphasize the need for social justice research and to highlight ways in which our community is uniquely positioned to contribute to this work. To motivate the QSIDE research agenda, we begin by introducing our framework for the concepts of inclusion, diversity, and equity, and by discussing the need for quantitative approaches to social justice.

Inclusion, Diversity, and Equity

Any potential advancement of inclusion, diversity, and equity (IDE) depends on a shared understanding of these values; we now describe QSIDE’s qualitative framework for them. *Diversity* refers to all of the differences that make individuals unique. Axes of diversity include, but are not limited to, gender, gender expression, sex, sexual orientation, race, ethnicity, national origin, age, religion, disability status, family status, and socioeconomic background. Empirical research in psychology and organizational theory has documented that diversity can drive creativity, good

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decision making, and a positive feedback resulting in more diversity, among other benefits (Markus and Nurius 1986; Galinsky et al. 2015).

In professional and academic settings, we often discuss the diversity of groups. But merely accounting for the identities and characteristics represented in a group is limiting. The notion of *equity* expands on diversity. In considering equity, we ask these questions: Who wants to be in the group but cannot be? What is stopping them, and how can those barriers be removed? It is important to distinguish between equity and another notion, namely, *equality*. There is a popular cartoon that tries to explain the difference between these concepts through a drawing of three people of different heights trying to look over a tall fence by standing on boxes (Craig 2016). Equality is depicted as treating everyone equally: the boxes are all the same height, so the shortest person can't see. Equity is depicted with boxes of differing heights, allowing all three people to look over the fence. One aspect of this cartoon is misleading, though, because it implies that it is a characteristic of the shortest person, namely their height, that requires a solution. It has been pointed out that inequities are not due to individuals themselves, but rather, are due to conditions that society creates. A more apt cartoon might picture three people of similar heights on a sloping ground, so inequitable access is properly attributed to external conditions (Sippin the EquiTEA 2018).

Even with diverse groups and equitable access, not all members of a group may feel welcome or heard. This is a challenge of *inclusion*. To make any community more fair and just requires a deep consideration of all three dimensions: inclusion, diversity, and equity. For instance, without attention to inclusion, initiatives aimed at expanding diversity often fail (Puritty et al. 2017; Diversity Doesn't Stick Without Inclusion 2017).

Another crucial IDE-related idea is *intersectionality*, first proposed by Kimberlé Williams Crenshaw in 1989 to describe the unique challenges that Black women face due to the intersecting identities of their gender and race (Crenshaw 1989). Crenshaw and others have broadened the term to describe the specific challenges of groups with multiple intersecting identities including LGBTQ status, gender, race, ethnicity, and disability. An intersectional approach is one that recognizes the unique challenges faced by those with multiple minoritized identities.

Quantitative Approaches to Social Justice

From the women's suffrage movement to the battle for civil rights and in many other struggles, people have long sought justice by protesting in the streets, fasting, inspiring others to speak up, and a variety of other approaches (Morris 2001; Crawford 2003). While social justice efforts continue to progress, two steps forward are often followed by one step back, as with the recent rollback of the Voting

Rights Act (The Voting Rights Act n.d.). At present, we live in a world with unprecedented computational power and access to data, potentially providing the opportunity to "step forward" by studying information about patterns and trends in society, hypothesizing causes, and critically examining problems and solutions.

The use of data to understand injustice is particularly important during a time of misinformation. While the globalization of information has brought many benefits, there are, nonetheless, well-documented cases of purposeful misinformation with negative consequences. For example, misinformation has supported the rhetoric that a wave of invading immigrants has brought increased crime to the US (Becker 2019).

Even in the absence of purposeful misinformation, data can address misunderstandings. One study of the perception gap between voters of political parties, for instance, asked Democrats to estimate what percentage of Republicans believe "properly controlled immigration can strengthen America" (Mounk 2019; Yudkin, Hawkins, and Dixon 2019). The Democrats estimated 52%, while in reality, 85% of Republicans in the study agreed with the statement. Conversely, Republicans estimated that 54% of Democrats are "proud to be American," whereas the measured value was 82%.

QSIDE is a community of scholars and practitioners working at the intersection of IDE, data, mathematics, and computing. We hope that our work will address challenges that have yet to be recognized as well as those that are already mainstream but poorly understood. We strive to provide mechanisms for scholars of diverse backgrounds, experiences, and interests to network and collaborate, and to reap the benefits of advancing their research while making the world a more just place. With deep roots in the mathematical sciences community and a research-in-to-action philosophy, QSIDE also depends pivotally on the collaboration of humanists and social scientists who are trained to think critically about social justice issues. Their participation ensures that research is correctly motivated, designed, executed, and interpreted, and that quantitative frameworks are transparent and minimize bias; see, e.g., *Weapons of Math Destruction* (O'Neil 2016).

QSIDE develops projects in two ways. First, potentially in collaboration with individuals and organizations empowered to influence IDE, the director conceives projects and recruits participants from the roster of QSIDE-affiliated scholars. Second, scholars who are currently conducting research that fits within QSIDE's vision may bring projects under the umbrella of the institute, whether or not they are already affiliates. While QSIDE's uniqueness derives from its focus on IDE, its community ties, and its collaborative and interdisciplinary approach, the organization exists alongside other groups concerned with quantitative approaches to challenges in society: Data Science for

Social Good, the Human Rights Data Analysis Group, the Annenberg Inclusion Initiative, the Metric Geometry and Gerrymandering Group, and various computational social science centers, to name a few.

Previous and Ongoing Work

From STEM to the arts to the justice system and more, QSIDE affiliates are active on a range of projects. We briefly describe several of these to show the variety of approaches that can provide social justice insights, including data mining, statistical analysis, mathematical modeling, analysis, and simulations.

A 2016 data mining study introduced a large-scale gender inference method in order to assess gender representation on 435 journal editorial boards in the mathematical sciences (Topaz and Sen 2016). This study, which was conducted by an applied mathematician and computer scientist who consulted with gender studies scholars, relied heavily on Amazon Mechanical Turk (MTurk). MTurk is an online crowdsourcing labor platform that allows *requesters* to hire workers to complete *Human Intelligence Tasks*, that is, tasks that a computer cannot be easily programmed to do. In (Topaz and Sen 2016), workers retrieved editorial board rosters from the internet and made gender inferences for each editorial board member. These inferences were validated by multiple workers and a random subset was validated by experts. In 2016, women made up approximately 16% of tenure-stream faculty positions in doctoral-granting mathematical sciences departments in the US. This study found that of the 13,000 editorships examined, only 8.9% were held by women, suggesting severe underrepresentation. Statistical tests revealed specific journals, subfields, publishers, and countries that significantly exceeded or fell short of the average.

A study of artists in major US museums (Topaz et al. 2019) brought together mathematicians, applied mathematicians, statisticians, and art scholars to expand the methodologies described above. This work inferred the gender, ethnicity, birth year, and national origin of over 10,000 artists whose works are held in the collections of eighteen museums. Of these, 85% were white and 87% were men. One might be tempted to attribute the high representation of white men to the collection mission of a museum, that is, its particular geographic and historical foci, as measured through national origins and birth years of artists. A statistical clustering analysis revealed that this attribution is not correct. More specifically, museums were clustered in two different ways: first, in the multidimensional space describing the overall gender and ethnicity profiles of their artists, and second, in the space describing their national origins and birth years. These two clustering schemes had essentially no correlation. That is to say, museums with very similar collection mission profiles can display markedly different levels of representation of women and non-whites,

suggesting that a museum wishing to increase diversity in its collection might do so without changing its geographic or temporal emphasis. As a result of the publication of this work, members of the research team were invited to discuss diversity issues with the staff of one museum in the study and were invited to study the internal proprietary data of a second museum to provide further insights on diversity.

In the realm of mathematical modeling, (Clifton et al. 2019) considered a minimal model for the roles of bias and homophily (self-segregation) in representation of women in professional hierarchies. The model consists of a system of differential equations for the fraction of women at each hierarchical level. The system includes parameters accounting for gender bias in the hiring process and for homophily, which in this context means self-selection to apply for a position or for promotion. Using dynamical systems analysis and parameter fitting based on data sets from real professional hierarchies, the investigators predicted fields that may have a stronger bias against women (e.g., mathematics and chemistry) and fields that indicate stronger homophily (e.g., engineering and nursing). In addition, the model provides a prediction of the time to achieve gender parity in various fields, and may be used to suggest the most effective interventions to reach this goal.

Adopting a stochastic outlook, (Maes 2018) constructed Markov chain models to study affirmative action. The undergraduate author of this work spent one year conducting background research on policy, history, and law, and spent one year performing quantitative modeling. *Affirmative action* policies are hiring and recruiting practices designed to combat discrimination against members of certain groups. These policies have been the subject of frequent litigation over the past forty years. Affirmative action policies are typically assessed through retrospective data analysis. That is to say, after a policy is put in place, subsequent shifts in demographics are measured statistically. In contrast, the Markov chain model of (Maes 2018) was developed for *ex ante* (based on a forecast) assessment of race-based affirmative action policies in US undergraduate college admissions and was calibrated on data from the University of California, Berkeley. The model predicts how affirmative action admissions policies will affect student body demographics, and it also suggests other interventions that might diversify a student body without the legal risks associated with affirmative action.

QSIDE researchers have ongoing projects in a range of applications related to social justice. One project applies network analysis and random process modeling to understand mass shooting events. A more theoretical project involves a sociologist and strives to build a quantitative theory of group diversity in which individuals are modeled as elements of a Boolean semiring on a multiplex network. To better understand equity in the justice system, QSIDE has partnered with volunteers from the Berkshire County

(Massachusetts) Court Watch project to carry out analysis of data taken by court observers during pre-trial hearings. In a second project related to the judiciary, applied mathematicians and a sociologist are examining sentencing patterns and disparities among judges in federal courts. One project on the horizon brings together musicians, applied mathematicians, an economist, and a political scientist to understand, and hopefully influence, diversity and inclusion in the professional music performance pipeline. In another initiative, QSIDE plans to investigate faith-based refusals of pharmacists to fill prescriptions for women's and LGBTQ health, and to provide publicly accessible data so that consumers can make informed choices about pharmacies. Several other projects are in nascent stages.

The Future of QSIDE

Beyond continuing the interdisciplinary QSIDE research agenda, we have several goals in mind. We plan to organize research workshops in order to highlight quantitative IDE research and to bring interested scholars together to connect. In order to increase capacity for the type of research we do, we hope to run training boot camps. A data science boot camp will provide scholars from the humanities and social sciences with sufficient background to be able to collaborate effectively with quantitative scientists. This boot camp will be based on a current boot camp that two QSIDE affiliates currently run at Williams College. Conversely, a social sciences and humanities boot camp will train quantitative scholars in some fundamentals of inquiry in those fields. Then, in order to incubate research, QSIDE will offer research grant opportunities that will support multidisciplinary work. To further effect change, we plan to develop a toolkit for researchers doing QSIDE-aligned work to help them influence policy. Ongoing support of participants in all of the aforementioned initiatives will be critical for their long-term effectiveness.

Get Involved

For some mathematical scientists, social justice work is a labor done separately from research. A central message of QSIDE's work is that this separation need not always exist. As a member of the mathematical sciences community, you have a powerful set of skills at your disposal and these can be used to address social justice. Social justice issues are challenging, complex, and benefit from the careful, abstract, quantitative thinking that we, as mathematicians, are trained to do. For those readers seeking to support a closer connection between mathematical sciences research and social justice, here are ways to contribute:

- Sign up for the QSIDE mailing list at our website, qsideinstitute.org.
- Share our website on social media and in your other networks.

- Support QSIDE financially through our website. As QSIDE's mission falls outside the scope of most research funding opportunities, we depend on private citizens and organizations for support.
- Get involved with quantitative IDE research. If you are interested in becoming part of our network, please contact us through the website.

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Credits

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