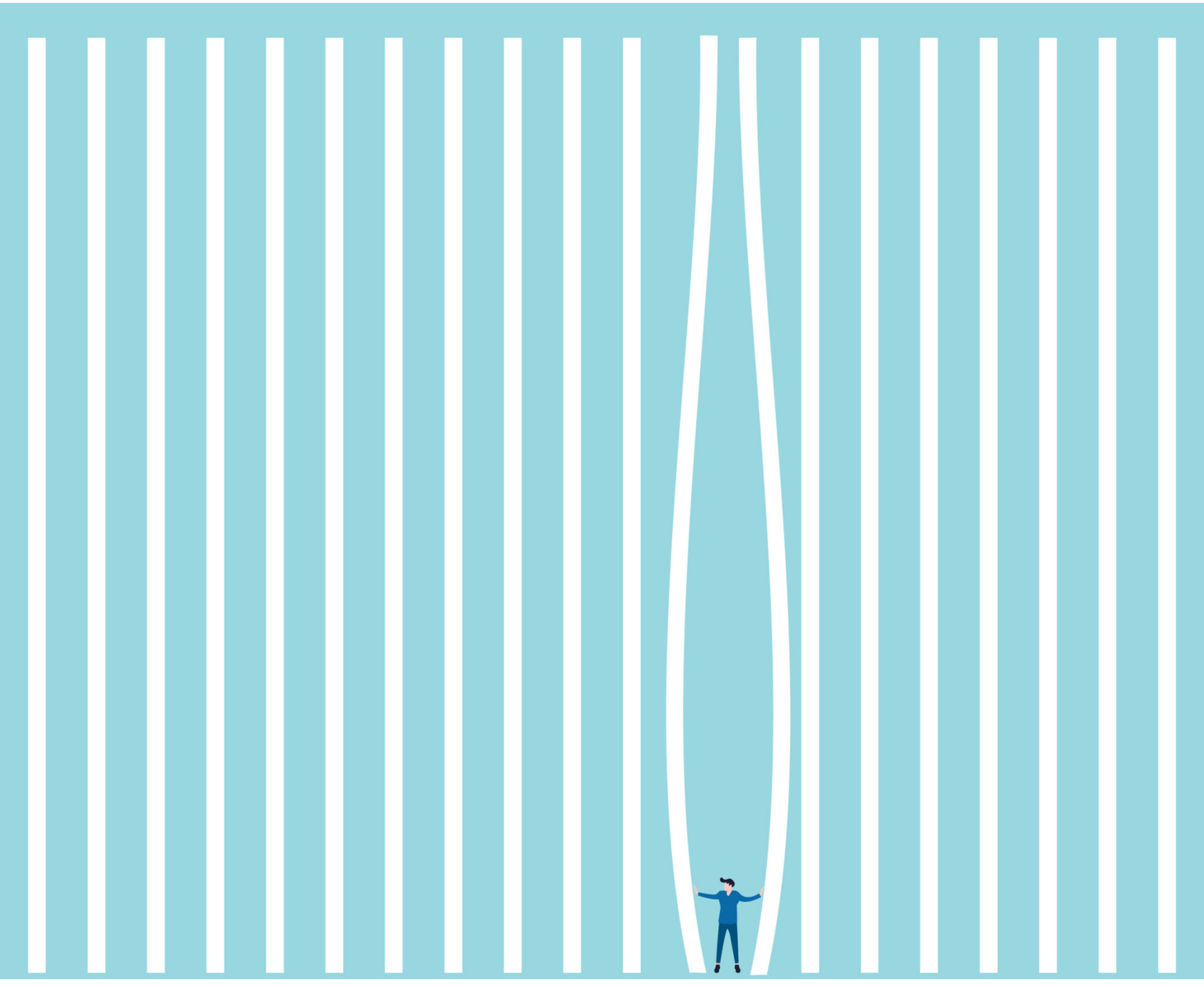
QuGrids



Minimizing Hidden Biases in Hiring

Evidence-Based Strategies for PIs

A project finance by the Ministerium für Kultur und Wissenschaft of Nordrhein-Westfalia

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Foreword

Across Europe, the evolution of the energy system from centralized, fossil-based infrastructures to decentralized, renewable-driven networks is reshaping both technological and societal priorities. The design, planning, monitoring, and operation of energy systems with distributed resources, user engagement, and multi-energy carriers is driving the advancement of digital solutions, including the emerging capabilities offered by quantum technologies.

As the interconnected energy system expands, the complexity of this evolving landscape stretches the computational needs, both for methods and infrastructure, to infeasible points, and it exposes the challenges in data transfer, latency, reliability, and cybersecurity. Quantum computing promises powerful means and tools for addressing computational scaling in planning and optimization, whereas quantum-based communication may form the foundation of more secure and resilient cyber-layer for operation.

This technological evolution unfolds alongside broader European efforts to secure long-term competitiveness and technological sovereignty. The 2024 Draghi Report identified quantum technologies as a critical driver of Europe's economic future, reflecting their growing influence across health care, logistics, finance, energy, and defense. Europe is a global leader in quantum scientific publications and hosts a strong talent base, yet a shortage of quantum-skilled professionals threatens to slow progress across key sectors.

In response, the 2025 European Quantum Strategy sets an ambitious goal: establishing Europe as a global leader in quantum by 2030. Within this strategy, five main areas of action were identified, with one priority (Area 5) being the building of a diverse, world-class quantum workforce. As a Quantum European Action Plan is expected in 2026, Germany has also released its Action Plan on Quantum Technologies, aimed at supporting Europe's Quantum Strategy and establishing Germany as a global leader in the field. Talent development is a central element of these strategies, with a focus on attracting and retaining excellence.

Within this context, diversity, equity, and inclusion (DEI) efforts play a crucial role. The quantum workforce, emerging from disciplines historically lacking diversity such as physics, engineering, and computer science, remains rather homogeneous. As Europe seeks to expand its quantum talent pool, questions about attracting and retaining talent at all levels are of key importance. This priority is also recognized in Germany's latest Hightech Agenda (Hebel 5). Broadening participation through DEI is essential to expanding the quantum talent pool and addressing the current shortage of skilled professionals. Germany and Europe cannot afford to overlook the potential of a diverse quantum workforce.

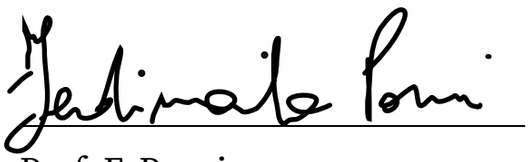
DEI is everyone's responsibility. Yet, when responsibility is shared by everyone, it can risk becoming no one's work. Within QuGrids, we recognize that advancing diversity, equity, and

inclusion in research requires collective commitment and action across the scientific community. As leaders of research teams, Principal Investigators (PIs) have a key role in shaping fair and inclusive recruitment and hiring practices. The choices they make throughout the recruitment and hiring process influence who has the opportunity to contribute to research and how teams evolve over time.

This manual is intended to support PIs in strengthening inclusive recruitment and hiring practices. It provides evidence-based insights and practical approaches to help guide decision-making and promote greater fairness, transparency, and inclusion throughout the hiring process.

At the same time, PIs do not operate in isolation. Creating more equitable research environments requires a shared commitment across the wider research ecosystem. Universities, research institutions, professional networks, and scientific societies all have a fundamental role in establishing the conditions that allow equitable and inclusive practices to be effectively implemented and sustained. This includes supporting fair selection processes through appropriate candidate management platforms, fostering reflection on how academic merit is defined and assessed, and ensuring that diverse perspectives inform institutional decisions.

The future of quantum technologies will depend not only on scientific and technological advances, but also on the people who drive them. While meaningful progress requires action at multiple levels across the research ecosystem, PIs have an important role in shaping the research teams that will develop the knowledge and innovations needed to address these challenges. We hope that the reflections and practical approaches offered here will encourage reflection and support recruitment and hiring practices that are fair, transparent, and inclusive.



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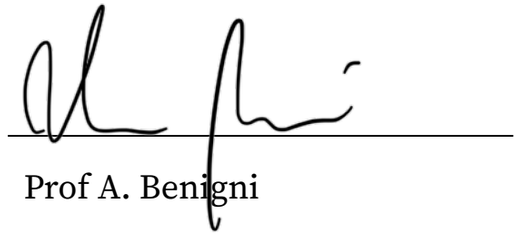

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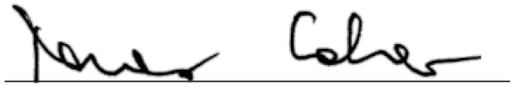

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Why a handbook for Principal Investigators?

In recent years, increased public and private investment in research and development, combined with a persistent shortage of highly specialized STEM professionals, has intensified competition for talent and placed public research institutions at a structural disadvantage in attracting and retaining researchers. At the same time, the STEM talent pool has become increasingly diverse, underscoring the need for recruitment practices that effectively reach, assess, and engage a broad range of candidates.

In this context, equipping PIs with the tools required to recruit excellent scientists, postdoctoral researchers, and doctoral candidates is essential to ensuring that institutes and research organizations can fulfill their missions. Effective recruitment requires processes that reach the full pool of qualified candidates and support fair assessment throughout the hiring process, including recognition of how hidden biases and structural barriers can influence recruitment, evaluation, and career progression. This handbook provides QuGrids PIs with practical tools to address these challenges and support more equitable hiring processes. While additional best practices in Diversity, Equity, and Inclusion (DEI) are relevant to hiring, they fall outside the scope of this handbook.

Gender equity is a central dimension of inclusive recruitment and hiring practices. The underrepresentation of women has historically affected many STEM disciplines, including several fields represented within QuGrids. However, gender does not operate in isolation: researchers' opportunities and experiences are shaped by multiple, intersecting dimensions of diversity. Addressing gender equity therefore requires attention to the broader contexts in which recruitment, career progression, and retention take place.

Gender equity in academia is often treated either as an abstract value to uphold or as a numerical target to achieve. Yet, now more than ever, diversity in all its forms is essential to the effective functioning and success of scientific teams. Fostering gender equity—and diversity overall—is, first and foremost, a commitment to scientific excellence. Inclusive and equitable recruitment and hiring processes are among the most effective ways to attract, retain, and advance talented researchers across all career stages.

The following sections examine available data on gender representation across disciplines relevant to QuGrids to provide context for current recruitment challenges and opportunities. They also introduce the concept of hidden biases and

discuss how these biases may influence perceptions, categorization processes, and decision-making during the hiring process. Individual-level approaches aimed at recognizing and reflecting on these processes are discussed; however, because such approaches alone have shown limited effectiveness in producing sustained changes in decision-making and outcomes, the handbook subsequently focuses on structural approaches. These approaches aim to embed equity throughout the hiring process—from drafting job descriptions and developing evaluation criteria to implementing diverse assessment methods and extending offers.

PIs remain responsible for assessing the feasibility of these measures within the structures of their teams and institutions and for coordinating their implementation. Interested PIs are encouraged to consult institutional resources or their respective HR departments for further guidance.

Why Gender Equity Still Matters in Research

In 2012, the European Research Area (ERA) established gender equality and gender mainstreaming as strategic priorities. Key objectives included removing barriers to the recruitment, retention, and career progression of women researchers, improving women's access to decision-making processes in science, and strengthening the integration of the gender dimension in research programs (European Commission, 2012).

Gender equality, however, remains an ongoing challenge. In 2018, cross-country evaluations revealed limited progress toward the ERA's gender equality objectives. Although most European countries had developed strategies to promote gender equality in research, progress remained slow. Continued efforts were needed to increase women's representation in science, reduce gender-based inequalities in research careers, remove barriers to advancement in research and innovation (R&I), and strengthen the integration of gender considerations into research and innovation activities (European Commission, 2019).

In 2021, the ERA reaffirmed its commitment to gender equality and gender mainstreaming through the Ljubljana Declaration on Gender Equality in Research and Innovation, the Pact for Research and Innovation, and the Policy Agenda for 2022–2024. Within this framework, gender equality and inclusiveness are recognized as characteristics of excellent research systems. These principles are not only fundamental to democratic values but are also essential for retaining valuable talent, fostering diverse perspectives, and generating knowledge and technologies that benefit society as a whole (European Commission, 2021a, 2021b; Council of the European Union, 2021).

Gender Equity Beyond Representation: A Systemic Challenge

Women's representation in science—at all career levels—is both a matter of social justice and scientific excellence. However, gender equity cannot be understood solely as a question of numerical representation or target achievement. Increasing women's participation in STEM research is not only about improving recruitment outcomes; it also requires ensuring that talented researchers can enter, remain, and progress within scientific careers. Recruitment initiatives and institutional outreach may contribute to improving representation, but addressing only visible outcomes without considering underlying barriers does not lead to sustainable change.

Addressing gender inequality requires action across multiple and interconnected levels. Relevant factors range from early educational experiences and societal perceptions of gender to the cultures and practices of academic institutions, research teams, professional societies, journals, and funding agencies. While research institutions cannot address all societal drivers of inequality, they have an important role in examining and improving the structures, practices, and environments within their own spheres of influence.

This document does not aim to provide a comprehensive overview of systemic approaches to gender equity. However, contextualizing QuGrids' gender equity measures is essential to understanding what can realistically be achieved within a research consortium and to highlighting the role of individual actors, particularly established scientists, in supporting more equitable research environments [1].

To place these considerations in context, the following section examines current patterns of gender representation across STEM disciplines relevant to QuGrids.

Gender Representation Across QuGrids-Relevant STEM Fields

According to the Institut der deutschen Wirtschaft (IW), in the third quarter of 2022, only 16% of all STEM workers in Germany were women. Women's representation in STEM occupations varies across the country; in states such as North Rhine-Westphalia (NRW), women's representation was even lower (14%) than the federal average. The lack of women among STEM graduates is often cited as a main explanation for the low representation of women in STEM careers. However, data on STEM graduates show that differences in interest and participation patterns vary across disciplines and countries. In other words, women's representation among STEM students and graduates differs substantially across fields, cultural contexts, and administrative systems (see Tables 1 and 2).

These differences become particularly visible when examining individual STEM disciplines. In the natural sciences, mathematics, and statistics, women are not underrepresented among Bachelor's and Master's graduates. Among German graduates in biology, chemistry, and geosciences, women have been equitably represented—or overrepresented—for more than a decade (Kompetenzzentrum Technik Diversity Chancengleichheit). Women's representation among Master's graduates in mathematics has remained above 30% since at least 2005.

Underrepresentation of women among STEM graduates is particularly pronounced in information and communication technologies, engineering, manufacturing, and construction, as well as in natural sciences disciplines such as physics and astronomy. Data from the Kompetenzzentrum Technik Diversity Chancengleichheit show that, although Germany has increased the number of women graduating from Bachelor's and Master's programs in electrotechnics, informatics, and physics over the past ten to fifteen years, women's representation has remained low due to a parallel increase in the total number of graduates (Figures 2, 6, and 10). Thus, while the pool of qualified candidates for positions requiring Bachelor's and Master's degrees has become larger, its overall gender composition has changed only slightly.

Regarding doctoral graduates, there have been no significant changes in women's representation in physics and electrotechnics. The overall number of doctoral graduates—largely dependent on available funding—has remained relatively stable, and the proportion of women completing PhDs has increased only marginally. Informatics, however, displays a more positive trend, with both the total number of graduates and the percentage of women among them showing a modest but steady increase over time (Tables 3, 4, and 5).

At first glance, across Europe, countries with a higher proportion of women graduating from doctoral programs appear to offer a somewhat larger pool of potential candidates for postdoctoral positions in physics, informatics, and electrotechnics. In Germany, women remain particularly underrepresented compared with several other countries (see Table 2). Nevertheless, Germany remains among the countries graduating the largest absolute numbers of women in physics, electrotechnics, and informatics [2].

Over the past decade, efforts to increase women's participation in STEM disciplines have yielded measurable results. The number of women enrolling in Bachelor's programs has increased

across all QuGrids disciplines over the last 10 to 15 years, although the extent of this increase varies by field. Nevertheless, calculated four-year graduation rates within Bachelor's programs in physics, electrotechnics, and informatics remain concerning, particularly for women (see Figures 3, 7, and 11) [3]. According to the Kompetenzzentrum Technik Diversity Chancengleichheit, women accounted for 29% of students entering a Bachelor's degree in physics in 2017 (30% in 2018). By 2020, however, only 24% of physics graduates were women, increasing slightly to 25% in 2021 [4]. A similar pattern emerges in electrotechnics, where women represented 15% and 16% of entering cohorts in 2017 and 2018, respectively, but only 11% of graduates. Graduation rates are somewhat higher in informatics: women constituted 25% and 22% of Bachelor's program entrants in 2017 and 2018, respectively, and 21% of graduates in both 2020 and 2021.

Looking at the data from a different perspective, during the most recent Bachelor's cycle (2020–2023), approximately three out of ten women graduated from physics programs within four years, compared with four out of ten men. In electrotechnics, four-year graduation rates were 46% for women and 57% for men. In informatics, however, women's four-year graduation rates surpassed those of men for the first time (62% versus 58%). Nevertheless, gender differences in progression through these disciplines remain a concern, particularly in disciplines expected to experience growing demand due to their strategic and economic importance.

Beyond the Pipeline: Understanding Persistent Representation Gaps

Women's underrepresentation in STEM is often attributed to pipeline issues, frequently framed as a lack of interest in disciplines such as electrical engineering, physics, and informatics. While women remain a minority in these fields, the pipeline narrative is potentially misleading because it overlooks the multiple factors that contribute to persistent underrepresentation in male-dominated STEM disciplines. Research shows that gender stereotypes, the scarcity of female role models and mentors, math anxiety and stereotype threat, biases in hiring, assessment, evaluation, and funding, as well as experiences of isolation, hostile climates, and early ability-related beliefs and preferences (see, e.g., Spencer et al., 1999; Casad et al., 2021; Ceci, 2018; Rosser, 2013; Shen, 2013) can all shape women's educational choices, persistence, and career trajectories.

A subtle risk of the pipeline narrative is that it may be interpreted as a rationale for focusing gender equity efforts exclusively on recruitment, rather than adopting a more comprehensive approach that also addresses retention, career progression, and structural barriers. Attention to these broader factors is essential to ensure that recruitment gains translate into sustained improvements in representation.

In this context, PIs play a key role in connecting recruitment efforts with discussions within institutes and faculties on student graduation rates and their intersections with gender and other dimensions of diversity. Differences in graduation rates have implications not only for gender equity but also for the long-term sustainability of research groups and the broader scientific and economic ecosystem. PIs also have a responsibility to remain informed about pipeline data. Monitoring these data is essential for setting realistic equity benchmarks and aligning recruitment strategies with the available talent pool.

Within QuGrids specifically, hiring benchmarks for postdoctoral researchers should ideally reflect the current pipeline in physics, informatic, and electrotechnics, based on women's representation among doctoral graduates in Germany and Europe (see Table 2). Monitoring institute-specific graduation and progression patterns can help identify challenges that may undermine recruitment gains. Crucially, PIs must also ensure fair hiring

processes to support equitable career progression and foster a group culture that sustains diversity and inclusion over the long term.

Notes

[1] Diversity, equity, and inclusion (DEI) practitioners often emphasize the role of individuals in fostering equitable and inclusive workplaces and societies. While individual behavior and commitment are important, it would be misleading to assume that persistent structural inequalities can be addressed through good intentions alone. Such approaches risk shifting responsibility from institutions and communities to individuals, thereby obscuring the critical role of leadership in driving organizational change. Measures such as awareness or diversity training may contribute to individual reflection, but on their own they have shown limited effectiveness in producing sustained organizational change. Meaningful progress requires institutional commitment, including investments in data collection, policy development, accountability mechanisms, and structural reforms. Many of these discussions must take place within professional societies, universities, research institutions, funding agencies, journals, and policy-making bodies. Senior scientists are particularly well positioned to initiate and lead these conversations.

[2] The classification of graduates varies across databases, particularly with respect to electrotechnics. Consequently, the figures presented in this report may be influenced by differences in classification systems.

[3] Four-year graduation rates were calculated using data from the Kompetenzzentrum Technik Diversity Chancengleichheit by comparing the number of students entering Bachelor's programs in a given year with the number graduating four years later. Calculations were performed separately for women and men to estimate the proportion of entrants completing a Bachelor's degree within the expected period.

[4] Graduation rates within the expected four-year period remain low in Germany across Physics, Electrical Engineering, and several other STEM disciplines. For example, in 2018, 19,328 students entered Bachelor's programs in Physics, but only 2,864 graduated four years later (approximately one in 6.7 students; for women, approximately one in 9.6). In Electrical Engineering, 26,538 students enrolled in Bachelor's programs in 2018, while 6,602 graduated four years later (approximately one in four students; for women, one in 5.1). Across all STEM disciplines, the average four-year graduation rate is approximately one in 3.4 students (one in 3.2 for women).

Databases

The Kompetenzzentrum Technik Diversity Chancengleichheit (LINK) provides data on women's representation among students and graduates in Germany. Although the database is available only in German, it can be explored by year, discipline, region, and degree level. For comparable data across Europe, Eurostat (LINK).provides statistics on students and graduates by gender, country, discipline, and educational level.

Understanding and Mitigating Hidden Bias in Academic Hiring

Today, workplace discrimination often manifests in subtle forms that are ambiguous, less overt, and frequently unintentional. Nevertheless, its effects are equally damaging for both individuals and organizations (see Jones et al., 2017). Acknowledging the role of cognitive biases in shaping our understanding of the world is a crucial first step towards creating more equitable hiring processes and research environments.

Cognitive biases can be defined as systemic "fallacies" in our assessment of people, events and situations that take place at an unconscious level and influence our judgments and behaviour [1]. These information processing errors occur universally. They have been observed in a variety of contexts, and people have been shown to display similar patterns in the way they deal with and process information (Shafir and LeBoeuf, 2002; Kahneman, 2011). Psychologists (see for instance Kahneman, 2011) have identified a variety of possible information processing mistakes. These errors occur in all spheres of life and raise significant questions regarding the equitability of our society and institutions.

For centuries, humans were assumed to be fully rational beings. Today, however, there is broad consensus that most decision-making occurs at a subconscious level. Each day, we make thousands of decisions, and deliberate evaluation of all available information is often not feasible. Actions such as braking to avoid an obstacle while driving, interpreting anger on someone's face, or deciding whether to trust a stranger at the door are processed automatically and require minimal cognitive effort. Drawing on knowledge accumulated both consciously and unconsciously, the mind employs various mental shortcuts—known as heuristics—to reduce complexity and accelerate decision-making, enabling rapid responses to potentially critical situations. This approach, referred to by psychologists as System 1 thinking (Tversky and Kahneman, 1973; Kahneman, 2011; Gigerenzer and Gaissmaier, 2011; Gigerenzer and Selten, 2002; Gigerenzer and Goldstein, 1996), is instrumental to survival. Nevertheless, it can lead to systematic assessment errors, also known as biases.

System 2 [2] thinking, by contrast, is more deliberate. It requires greater cognitive effort and longer processing times and usually takes over when we need to solve complex problems or encounter unfamiliar situations that do not

demand immediate action. However, it does not necessarily yield more accurate judgments (Gigerenzer and Gaissmaier, 2011). Moreover, System 1 and System 2 thinking are interconnected: because System 1 continuously generates inputs and suggestions for System 2, biases may also influence more deliberate decision-making processes.

Hidden biases are a specific type of information-processing error, in which previously assimilated information about certain groups is unconsciously used to shape judgments and behaviour toward individuals within those groups. Like other cognitive biases, hidden biases operate at an unconscious level and originate from automatic brain processes. Consequently, an individual's explicit beliefs about a group may differ substantially from their implicit attitudes.

For example, while a person might consciously believe that both women and men are equally capable of caring for young children, they might nonetheless feel an unconscious hesitation to hire a male babysitter over a female babysitter, and potentially overlook qualified male candidates. Individuals can thus unknowingly perpetuate discriminatory behaviour. Hidden biases may therefore shape thinking and behaviour, adversely affecting outcomes for marginalized groups across domains such as employment, healthcare, policing, and the justice system (Hall et al., 2015; Spencer et al., 2016; Faigman et al., 2012).

Throughout our lives, we continually construct and utilize categories—collections of information about individuals perceived to belong to a common group—to make sense of the surrounding reality. Evolutionary psychologists have proposed that categorization and category activation may have evolved in response to the human need to distinguish allies from enemies (Cosmides et al. 2003). For many years, category activation as been considered an unavoidable mental process (Allport, 1954; Devine, 1989; Pratto & Bargh, 1991; Brewer, 1988). Consequently, research has largely focused on strategies to mitigate reliance on information derived from these automatic processes (Moskowitz, 2010).

More recently, however, studies have demonstrated that contextual factors—such as motivation, time constraints, and cognitive load —affect category application (e.g. Bodenhausen et al., 1999; van Knippenberg et al., 1999; Moskowitz, 2010), suggesting that category activation can be inhibited under specific conditions. For example, category-based thinking is less likely to be activated when individuals engage in counter-stereotypic mental imagery (Blair et al., 2001). Sinclair et al. (1999) found that category activation or inhibition is influenced by self-protective motives, while Moskowitz et al. (2000) demonstrated that individuals with an intrinsic egalitarian goal are more likely to inhibit category activation.

Harvard Implicit Association Test

The Harvard Implicit Association Test (IAT) was developed to assess an individual's implicit attitude—that is, their unconscious feelings, opinions, or beliefs about people or concepts— and to measure the strength of associations between specific groups and corresponding stereotypes or judgments.

Although the correlation between IAT scores and biased behaviour remains under investigation, there is broad agreement that while a single IAT may not reliably predict an individual's behaviour at a specific moment, aggregate results across participants can provide meaningful insights into behavioural tendencies.

For more information or to take an IAT, visit the Project Implicit website (LINK)

Additionally, egalitarian goals, when temporarily activated, may reduce stereotypic responding (Shah, 2003). However, attempts to counteract bias through conscious thought monitoring are often ineffective, as thought suppression can produce ironic rebound effects (Wegner & Erber, 1992; Macrae et al., 1994). More broadly, research suggests that aspects of goal activation and cognitive processing occur outside of conscious executive control (Bargh, 1990), limiting the effectiveness of purely introspective strategies for bias reduction. By contrast, environmental cues such as personal details and situations that highlight a person's individual characteristics (rather than their social group) can reduce automatic stereotyping (Macrae et al., 1994).

Cognitive Biases

Scientists have identified a variety of cognitive biases that shape how we process and interpret information. Below are examples of cognitive biases that can affect decision-making during the hiring process.

- **Affinity bias:** This occurs when candidates are evaluated positively or negatively not because of their abilities but because of perceived similarity with the evaluator. In academia, such affinities may arise from shared life experiences, research interests, academic lineage, or similar career trajectories.
- **Confirmation bias:** This type of bias occurs when information about a candidate is selectively interpreted to confirm an evaluator's initial assessment.
- **In-group bias:** Candidates may be unconsciously favoured by members of the hiring committee based on a social identity perceived as shared with the evaluator. For example, candidates may be preferred if they attended the same doctoral programme, share a cultural background, or appear to hold similar values.
- **Halo effect:** Here, the overall assessment of an applicant may be disproportionately influenced by a single positive attribute, such as their alma mater or the reputation of their co-authors.
- **Saliency bias:** This bias occurs when evaluators focus on one striking piece of information about a candidate—such as the number of publications or a grade on a diploma—and use it exclusively to form their judgment.
- **Attribution bias:** This happens when evaluators attribute a candidate's behaviour or achievements to their character rather than to contextual factors. For instance, a candidate may be deemed "lazy" for taking an extra year to graduate without considering personal circumstances, such as childcare responsibilities or cultural adaptation. Similarly, a postdoctoral applicant may be labelled as "lacking motivation" based on a publication record without accounting for the high-risk nature of their doctoral project.
- **Conformity bias:** This bias occurs when evaluators change their opinion about a candidate to align with the views of other committee members

Individual strategies for reducing hidden bias

The persistently low representation of women in STEM—particularly in leadership positions—has led the European Union mandating institutions participating in Horizon Europe programmes to implement training modules to minimize the effects of gender bias. However, there is little consensus regarding the effectiveness of such interventions (Paluck et al., 2009; Paluck et al., 2020; Kalev et al., 2006; Forscher et al., 2019).

Research suggests that training programmes aimed merely at familiarizing participants with the concept of hidden bias may, in some cases, backfire by reinforcing the perception that such biases are inevitable and cannot be meaningfully mitigated. Moreover, "quick-fix" strategies intended to reduce stereotype activation—such as prompting participants to imagine counter-stereotypical examples—have been shown to produce only short-lived effects, typically lasting less than 24 hours (Devine et al., 2012). Consequently, their practical impact on minimizing bias in real-world hiring contexts appears negligible.

At the individual level, Devine et al. (2012) developed an intervention programme that yielded promising results in achieving longer-term reductions of hidden biases. The programme combined several techniques designed to be practised and reinforced over time. At the outset, participants were introduced to the concept of hidden bias and made aware of their own biases through the Implicit Association Test. They were then provided with five strategies for bias reduction to apply independently in the following weeks: stereotype replacement, counter-stereotype imagining, individuation, perspective taking, and increasing opportunities for intergroup contact (see box below for details). Participants who completed the programme showed measurable reductions in hidden bias after four weeks, with effects persisting for at least eight weeks. Yet, implementing this approach at an institutional level poses challenges: its long-term effectiveness is uncertain, and success depends on participants' sustained motivation to actually apply the strategies proposed. However, the extent to which individuals consistently maintain such practices over time may vary, even when they are beneficial at personal, organizational, or societal levels, suggesting the need for complementary structural measures.

Gender biases in academia

Even though the number of women in science has substantially increased over the last fifty years, and media representations of female scientists have become more common, children—particularly older children—still tend to associate science with maleness. The quintessential scientist in the public imagination remains a middle-aged man (Miller et al., 2018; Ferguson et al., 2020).

Women remain underrepresented among master's and doctoral students in physics, informatics, and electrotechnics. Given the current talent pipeline, expecting women's representation among postdoctoral researchers and early-career scientists in leadership positions to reach 40–50% within the next decade is unrealistic. Doctoral graduation rates over the past decade illustrate this imbalance: women earned approximately 20–26% of doctoral degrees in physics, 8.5–18% in electrotechnics, and 13–26% in informatics [3].

One might therefore assume that, given the scarcity of female talent in the pipeline and the highly competitive academic job market, hidden biases play only a limited role in hiring decisions. In contexts where demand for talent exceeds supply, sex and gender might appear largely irrelevant. Empirical evidence, however, does not support this assumption. Women continue to face significant disadvantages when applying for academic positions, including in highly competitive STEM fields.

Bias replacement and bias inhibition strategies

Devine et al. (2012) developed an approach to inhibit the activation of hidden biases that shows promising results in the medium term. The approach combines a variety of bias-replacement and bias-inhibition techniques to be practised over time. These include:

- **Stereotype replacement:** This strategy requires individuals to recognize when they are reacting based on a hidden bias. They are then encouraged to reflect on what triggered the bias and modify their response, while developing strategies to prevent similar biases in the future. For example, while evaluating a CV, you might notice that you quickly dismissed a candidate who took one year of parental leave during their doctoral degree. Although everyone is entitled to parental leave, gender norms and dominant discourses about scientists might lead you to unconsciously view the candidate as disengaged or low achieving. Recognizing this bias allows you to pay closer attention when making judgments about candidates with career gaps due to childcare.
- **Counter-stereotype imagining:** This strategy encourages individuals to think about real or imagined people who do not fit societal stereotypes. For example, you might display pictures of famous women in physics in your department or create screensavers for your institute featuring women performing laboratory work.
- **Individuation:** The goal of this strategy is to prevent the automatic association of a candidate with a social category. For instance, before inviting a researcher for an on-site interview, it can be beneficial for the hiring panel to receive detailed information about the candidate, shifting the focus from their gender, nationality, or other group characteristics to the individual.
- **Perspective taking:** This strategy involves imagining the experiences of someone from a marginalized or minority group. While it does not need to occur during the hiring process, it can be applied broadly within your discipline to enhance awareness of diverse perspectives.
- **Increasing opportunities for contact:** Exposure to individuals from diverse backgrounds and life experiences can reduce biases by reshaping perceptions of others. Continuous opportunities for interaction with non-ingroup members—through cultural festivals, campus celebrations, employee network events, international conferences, or cross-border collaborations—can positively influence bias reduction in hiring.

Evidence suggests that hidden biases continue to influence hiring decisions, particularly for positions traditionally held by men. Research by Isaac et al. (2009) and Johnson et al. (2016) indicates that women stand virtually no chance of being hired when no other female applicants are shortlisted. Letters of recommendation can also disadvantage women: Madera et al. (2009) found that letters written for female candidates contained significantly more "doubt raisers" than those written for men, and women were overall less likely to receive a job offer. Similarly, Moss-Racusin et al. (2012) showed that faculty members favored candidates with male names over identically qualified female candidates for laboratory manager positions; male applicants were not only more likely to receive an offer but were also offered higher starting salaries.

The influence of hidden biases extends beyond hiring decisions and continues throughout academic careers. Teich et al. (2020) found that women were significantly under-cited in physics journals, while Ni et al. (2021) reported that women were more likely to experience authorship and naming disputes. Women are also severely underrepresented among recipients of scientific awards in the physical sciences, biomedical sciences, and mathematics (Lincoln et al., 2012), and a meta-analysis by Bornmann et al. (2007) suggests that gender biases also affect grant funding decisions.

The empirical evidence is not uniform, however, and demonstrates that gender bias is highly context-dependent. Williams et al. (2015) conducted five experiments in which faculty members from biology, engineering, economics, and psychology evaluated identically qualified applicants for assistant professorships. Across these experiments, female candidates were preferred over equally qualified male candidates by a ratio of approximately 2:1. This advantage disappeared, however, when female candidates were presented as only slightly less qualified than their male counterparts (Ceci et al., 2015). Importantly, these studies examined exceptionally qualified candidates with nearly identical academic records. In reality, career trajectories are rarely comparable. They are shaped by multiple factors, including the unequal distribution of household and caregiving responsibilities, biological factors such as pregnancy and maternity, access to professional networks and mentoring, institutional service expectations, and other structural conditions that influence academic careers.

National data from Germany also suggest that progress has been made. In recent years, women have been slightly more likely than men to be appointed to formal professorships (GWK, 2020). However, these data exclude direct appointments —cases in which candidates are hired without a formal selection process—as well as internal promotions. While such informal recruitment practices are relatively uncommon for Berufungen (formal professorial appointments), they are more frequent for junior and mid-career leadership positions that are not linked to university appointments, where recruitment often follows less structured procedures. Comparable data are not available for other academic positions, such as postdoctoral appointments, making it difficult to assess the extent of gender disparities in these recruitment processes.

Notes

[1] While science is often considered a value-free discipline guided by objectivity, contemporary philosophers of science increasingly challenge

this narrative, highlighting the influence of various biases on scientific practice (e.g., Douglas 2009; Harding 1998; Longino 1990; Kourany 2003). For further discussion on this topic and practical recommendations for minimizing bias in research, see Fernandez Pinto (2023).

[2] System 1 and System 2 thinking are convenience label employed by Kahneman to explain how the mind works; these, however, do not exist as such nor have a distinct location in the brain.

[3] Importantly, the proportion of women applying for postdoctoral positions does not necessarily mirror these graduation patterns; in practice, PIs often receive an even smaller share of applications from female candidates. Consequently, combining bias-prevention measures with targeted recruitment strategies aimed at both attracting and developing talent is essential.

Behavioral approaches to bias reduction

In contrast to approaches that primarily target individual awareness, behavioural approaches to bias reduction focus on redesigning the decision-making environment (Bohnet, 2016). In the context of hiring, this shifts the focus from training people to think differently, to designing processes that guide them toward less biased decision making.

This section is organized around the hiring process, from drafting a job posting to extending a job offer. While it is recommended that each section be read in full, the manual can also serve as a practical resource supporting PIs in implementing specific steps of the process. Not all suggested measures need to be applied; instead, PIs can determine which strategies are most appropriate for their teams and context.

Developing effective job descriptions

Research shows that the composition of the applicant pool strongly affects the likelihood of hiring women. Isaac et al. (2009) found that bias against female candidates decreases when women make up at least 25% of the pool. Johnson, et al. (2016) show that women are significantly less likely to be hired when they are the only female finalist in a candidate pool, consistent with tokenism effects in evaluation processes. These findings highlight that maintaining a sufficiently diverse applicant pool is a key strategy for reducing gender bias and promoting more equitable hiring outcomes.

One of the earliest opportunities to influence the diversity of an applicant pool lies in the design of the job description itself. Once staffing needs have been identified, the wording, structure, and framing of a vacancy can significantly shape who feels addressed and encouraged to apply. Ensuring that job descriptions resonate with a diverse talent pool is therefore an important step in reducing bias that may arise when a position is implicitly framed for a narrow or assumed audience during the attraction stage.

Organizations can reduce hidden biases by carefully designing the recruitment process itself, starting with effective job descriptions (see box below). This involves considering both the requirements for the position and how the job description will be perceived by potential applicants. Later, in the design of the selection phase, the job description provides an important foundation for structuring selection procedures and related assessment materials.

Contrary to common belief, there is little robust evidence that women are less likely to apply for a job simply because they do not meet all listed qualifications. Recent research by Salwender and Stahlberg (2024) suggests that the widely cited "100% qualified" claim is overstated, as no robust gender differences in application intentions were found across different qualification-fit scenarios. Similarly, there is limited evidence that merely reducing the number of listed essential requirements increases the share of qualified female applicants. However, HR best practices—such as clearly distinguishing between essential and desirable criteria, separating trainable from non-trainable skills, and eliminating ambiguous language—can improve the clarity of job advertisements and help attract suitable applicants across the broader talent pool.

Studies show that language in job advertisements can significantly influence whether women apply for a position. A well-known study by Gaucher et al. (2011) demonstrated that gendered wording—terms stereotypically associated with masculinity or femininity—can reinforce gender inequality in traditionally male-dominated occupations. The authors found that job advertisements for male-dominated roles contain significantly more masculine-coded language, and experimental evidence indicates that women perceive such positions as less attractive.

Building on this, He and Kang (2025) examined how more subtle variations in wording shape applicant behaviour. Across four multimethod studies, they showed that replacing masculine-coded terms with gender-neutral alternatives increased the likelihood that both

Internal job requirements, value proposition, and job description

Job Requirements

A job requirements analysis is the first step before drafting a job advertisement. It clarifies what the role involves and what is needed to perform it effectively. The analysis begins with defining the main tasks of the position. This includes outlining what the new team member will be expected to do on a day-to-day basis.

Next, the necessary skills and competencies are identified:

- Hard skills: training or university degrees, professional experience, specialist knowledge
- Soft skills: social, methodological, and personal competences.
- Mandatory requirements are essential for performing the core tasks of the role
- Desirable requirements are additional skills or knowledge that may strengthen a candidate's profile but are not strictly necessary

When defining these criteria, consider the expected applicant pool. Requirements should not be set too narrowly, particularly in fields with a shortage of skilled workers. Reflect on which skills candidates must already have, and which can be developed on the job.

Some guiding questions:

- What tasks will the new team member perform?
- What skills or knowledge are essential to perform these tasks?
- Which additional skills or knowledge would strengthen the candidate's effectiveness?

Value proposition

Alongside job requirements, it is important to consider the value proposition of the institution and the team. The value proposition describes what the position offers candidates—for example, development opportunities, team culture, working conditions, or meaningful aspects of the work.

When defining the value proposition:

- Keep in mind what may be attractive to a diverse talent pool.
- Illustrate it with concrete examples or clearly defined outcomes, rather than general statements.
- Highlight what makes your team or institution unique, including career development opportunities, benefits, or workplace culture.

Questions to consider:

- Why should someone apply for this position?
- What can the team or institution offer that would appeal to a diverse group of candidates, especially those from minority backgrounds and women?
- Are there benchmarks, achievements, or specific examples that make the role more tangible and appealing?

Job description

The job description is developed based on the job requirements and value proposition. It communicates clearly what the role entails and what the organization offers. A comprehensive job description typically includes:

- A summary of main tasks and responsibilities
- The mandatory and desirable skills and competencies
- The value proposition of the team and institution, with concrete examples
- Expected salary range and any flexibility
- Details of the application and selection process, including required materials and evaluation steps
- The timeline for filling the position

A structured approach ensures that the job description is clear, realistic, and inclusive, helping to attract qualified candidates while providing room for growth within the role.

women and men who do not strongly identify with masculine traits submit applications. Taken together, these findings highlight that linguistic choices in job advertisements can actively shape the composition of applicant pools.

Beyond wording, job advertisements also communicate information through broader symbolic signals about the organizational environment. One important form of such signalling is the use of diversity cues—textual or visual elements intended to convey an inclusive organizational culture. These cues are widely used in vacancies, recruitment platforms, and organizational websites within the German research and academic context, often with the expectation that they will encourage applications from women and underrepresented groups.

Checking job descriptions

Your HR department might already review job postings for biased language. If not, you can use various tools to quickly analyze the text of your vacancies. Software, such as *Totaljobs, GenderDecorder* and *GenderDecoderDE,* is designed to identify gender biases in job advertisements and is freely available online. Alternatively, if you have an MS Office license, you can use MS Word's Editor to check your text for inclusiveness.

To enable this feature on your PC:

- Open MS Word and click File in the top-left corner.
- Select Options and then Proofing.
- Enable Mark grammar errors as you type and open the settings next to Grammar & Refinements.
- Scroll down to Inclusiveness and check all boxes for biases (e.g. age, gender, cultural).

Supporting this assumption, Purdie-Vaughns et al. (2008) showed that minority individuals are highly attentive to representations of diversity and cues signalling inclusion. McNab and Johnston (2001) similarly found that women applicants respond more positively to advertisements that explicitly emphasize equal employment opportunity. Avery et al. (2004) similarly reported that minority job seekers were more attracted to organizations portraying other minority employees, even when those depicted belonged to different identity groups than the observer. Avery (2003) further observed that minority applicants' attraction to an organization increased when racial diversity was depicted, particularly in higher-status or supervisory roles, suggesting that not only the presence but also the positioning of diversity matters. Research by Plaut et al. (2011) indicates that the type of diversity message also matters: multicultural messaging tends to enhance feelings of inclusion among minority applicants more effectively than colourblind approaches. These studies collectively suggest that diversity cues can be effective in attracting applicants—provided they are meaningful and clearly communicated.

A more recent study by Wilton et al. (2020) showed that diversity cues may backfire when there is a perceived mismatch between an organization's diversity messaging and its actual demographic composition. In their studies, ethnic minority participants reacted less positively to organizations that strongly emphasized diversity while exhibiting low levels of visible minority representation. Such mismatches, in fact, reduced expected belonging, and raised greater concerns about fitting in at that organization. Furthermore, recent evidence suggests that the presence of diversity cues alone may not be sufficient. Nichols et al. (2023) found little indication that showcasing organizational diversity—such as displaying images of a diverse group of employees on a company website—significantly increased the representation of any subgroup in the applicant pool. These findings suggest that merely symbolic displays of diversity may not be enough to shape applicants' behaviour, raising the question of how organizations can convey

tangible, well-communicated commitments to inclusion that genuinely resonate with potential candidates.

Photos

PIs might consider including an image along their job descriptions. This provides them with an opportunity to present the team and its work environment in a visible and tangible way. Furthermore, it can support the overall attractiveness of the position and help potential applicants gain an impression of who the vacancy is aimed at, while also offering cues about the team's culture and the broader institutional environment.

Ideally, the selected image reflects the actual diversity of team with the vacancy and is appropriate for the role. Organizational units may consider investing in the development of an institute-specific image database that can be used for future vacancies and for website content. This can support consistency and reduce effort over time.

Diversity cues can be incorporated into images to further signal attention to equity and inclusion. At the same time, it is important that the photo authentically reflects the real work environment and existing inclusion practices. Visual representation should align with actual practices within the organizational units and be supported by clear and consistent messaging on the group's webpage.

Designing evaluation processes

Selecting applicants for a position can be particularly challenging. Choosing one candidate over another inevitably involves uncertainty about future performance, especially when evaluators have not previously worked with the applicants. Uhlmann and Cohen (2005) demonstrated that establishing hiring criteria before learning a candidate's gender reduces the influence of social stereotypes in the assessment of qualifications. Carefully deliberating in advance on what to evaluate, and on how these criteria align with staffing needs, can therefore provide valuable guidance and help mitigate bias during the selection process.

Evaluation Matrices

Evaluation matrices are structured tools designed to assess applicants for a specific position. They provide evaluators with clear guidance on what is being evaluated and how performance is measured. Diversity, equity, and inclusion practitioners frequently advocate for the use of such matrices—or rubrics—to mitigate bias in hiring and promotion processes. Their primary purpose is to enhance the quality of hiring decisions by slowing down evaluators' judgments and ensuring attention remains focused on the essential skills and knowledge required for the position, rather than on instinctive or impression-based assessments. Increasingly, therefore, universities have begun to require the use of evaluation matrices, particularly for appointments above the postdoctoral level.

Empirical evidence on the effectiveness of evaluation matrices, however, remains limited and somewhat mixed. Blair-Loy et al. (2022), for instance, found that the adoption of matrices was associated with an increase in the hiring of women. Nevertheless, women continued to receive lower evaluations than men on key criteria such as research productivity and impact.

Similarly, Culpepper et al. (2023) observed that while rubrics initially encouraged hiring committee members to focus on pre-established

criteria, their influence often weakened over the course of the selection process. In some cases, evaluators gradually reverted to more holistic judgments, allowing informal impressions and subjective factors to regain influence in decision-making. This suggests that, while evaluation matrices can structure attention and improve consistency, their effectiveness may depend on sustained use and institutional commitment throughout the entire hiring process. For rubrics to be effective, PIs need to implement internal processes that ensure their consistent application across all stages of the hiring cycle. For example, when multiple individuals are involved in the selection process, the PI may monitor adherence to the rubric. Additionally, all reviewers should receive appropriate training on how to apply the matrix effectively.

While rubrics hold significant promise for improving equity and consistency in hiring, it is crucial to remember that they are tools used by people to make decisions. Their effectiveness depends on both design and implementation. Evaluation matrices can themselves reflect and reproduce bias if their criteria are not carefully constructed, producing unintended negative outcomes for underrepresented applicants (Ulhman & Cohen, 2005; Blair-Loy et al., 2022). For instance, a matrix that includes "experience with grants" and scores candidates based on the number of grants received may inadvertently disadvantage women, who have been shown to receive less third-party funding on average. Hence, when developing evaluation matrices, it is essential to ensure that they accurately reflect the genuine needs of the hiring team while avoiding criteria that disproportionately disadvantage marginalized groups. This is a complex task, as those designing evaluation criteria may be unaware of embedded biases and often have limited exposure to the topic. Similarly, women and individuals from minority backgrounds frequently engage in invisible labour—for instance mentoring, roles on hiring committees, participation in outreach initiatives, or involvement in DEI activities—that is rarely taken into account during selection stages.

PIs, who are ultimately responsible for ensuring that evaluation matrices are as bias-free as possible, should consider familiarizing themselves with the topic. They can, for example, participate in awareness-raising campaigns such as those offered by the their university or research centre or by professional networks.

Another crucial aspect to address before the selection process is not only what the evaluation matrix should include, which selection elements will be used, and how the matrix should be operationalized for each tool, but also when and how candidate evaluations will be conducted. PIs play a central role in defining and communicating these procedures in advance. Bohnet et al. (2016) observed that comparative evaluations—where candidates are assessed side by side on each criterion rather than sequentially—are particularly effective in reducing bias activation. Therefore, it is important that PIs clearly instruct evaluators on the use of selection materials and require comparative evaluations whenever possible. For example, during CV screening, evaluators might first assess all candidates on criterion A, then all candidates on criterion B, and so on. Similarly, while reviewers should avoid discussing candidates prior to formal selection meetings, they should be encouraged during these meetings to compare candidates directly within specific assessment areas.

Assessment components in early- and mid-stage selection processes

Traditionally, hiring outside of W positions follows a two-step process: 1. pre-assessment by reviewing CVs and research samples—sometimes accompanied by university

Evaluation matrices

After a job description has been developed, you should be able to identify basic requirements, essential skills, and preferred skills for the position. Different rubrics (or matrices) are usually developed for different stages of the hiring process, as scoring is based on different types of data. At a minimum, operationalization should be revisited at every hiring stage.

Basic requirements

Basic requirements are usually yes/no criteria that, at the beginning of the selection process, help you filter out unsuitable candidates. For instance, if you are hiring a postdoc, you might list having a doctoral degree—or being about to complete a doctoral degree in a relevant area—as an essential requirement. Alternatively, if the position needs to be filled immediately, you might indicate that having a valid work permit is a requirement for the position.

Essential skills

Essential skills are crucial abilities that an employee must have to effectively carry out their job responsibilities after being hired. While these skills are typically trainable, training existing or new employees might not always be feasible due to time constraints or resource limitations. Unlike basic requirements, assessing essential skills is not as straightforward as checking a box; rather, they exist along a spectrum. As a result, candidates may demonstrate varying levels of proficiency in specific competencies.
To enhance candidate assessment, it is advisable to define the significance of different skill levels and establish a minimum proficiency level necessary for the position prior to the evaluation process. Candidates should then be evaluated individually according to the defined methodology, and an evaluation matrix should be completed for each candidate immediately after assessment.
For example, if the assessment involves reviewing CVs, work samples, and conducting interviews as primary decision-making aids, it is essential to:

- Specify the skills being assessed at each stage of the evaluation.
- Identify and clearly define competency levels.
- Assign an evaluation value to each competency level (e.g. -2 points = insufficient, +2 points = excellent).
- Set minimum proficiency requirements for each skill.

Consequently, a new candidate evaluation form should be generated for each assessment stage. Applicants who do not meet the minimum competency levels necessary for success can be excluded from the applicant pool. Instead of limiting interview invitations to only the top candidates (e.g. top three applicants), it may be beneficial to expand the finalist pool to include other suitable applicants to maximize diversity, especially if candidates scored similarly during a first evaluation (e.g. top six applicants).

As you develop your ideal assessment, it is important to consider the weight of each evaluation criterion and the minimum required score for each criterion evaluated through different assessment tools designed to select finalists for the position (Bohnet, 2016). For this purpose, you might first identify assessment tools for each selection criterion and then develop evaluation matrices to be used at each step of the evaluation, indicating the weight of each criterion.
Acknowledging the varying importance of skills is essential for a balanced evaluation process. For example, when assessing candidates for doctoral vacancies, assigning weights to different skills ensures that their relative significance is reflected accurately. In this context, you may decide to allocate 20% weight to communication skills, 35% to Python proficiency, and 35% to C++ capabilities, aligning with the specific requirements of the position.

performance reports and letters of recommendation—and 2. final assessment by conducting interviews, often paired with a research presentation or other simulative elements.

However, these elements are not the only options, nor should they automatically determine decision-making when they do not yield relevant information. As in research, the choice of method and tools should be aligned with the question at hand. Reviewing the job description is therefore a crucial first step in clarifying what is to be assessed in the selection process and how this will be measured.

A range of elements can be used to assess applicants throughout the selection process, including CVs, interviews, work samples, reference letters, general mental ability tests, and interviews. The following sections examine these elements in greater detail discussing the effectiveness of each tool, their potential for bias as well as practical challenges in the implementation of current DEI best practices.

Candidates' résumés or curriculum vitae (CVs) are among the most widely used selection elements for assessing a candidate's ability to perform a specific job. They provide important information about education, professional experience, and relevant skills.

Nevertheless, CVs often include personal information that can inadvertently trigger biases, even without any conscious intent on the reviewer's part.

Budden et al. (2008) found that the introduction of double-blind review was associated with increased representation of female authors in ecology journals. Similarly, Tomkins et al. (2017) provide evidence that single-blind peer review can introduce biases related to author prestige and institutional affiliation, which are reduced under double-blind review conditionsLikewise, a classic study by Goldin and Rouse (2000) demonstrated that screening musicians' identities during auditions increased the proportion of women hired in symphony orchestras. Taken together, these findings suggest that reducing access to personal identifiers can meaningfully alter evaluation outcomes.

Building on this evidence, Bohnet (2016) strongly advocates for double-anonymized selection processes to reduce biases in academia, including in hiring, funding decisions, peer reviews, and, in some cases, access to key equipment and technologies. Accordingly, removing personal identifiers from applications and evaluation materials can be a powerful strategy for reducing bias activation, particularly in the early stages of the selection process.

However, translating this principle into hiring practice requires careful consideration of both (a) which details can be effectively anonymized and (b) how anonymization can be implemented in practice. If the talent pool is sufficiently large to allow for a meaningful double-anonymized process, basic CV details —such as the candidate's name, date of birth, parental status, nationality, and disability status [3]—can be removed to minimize bias activation. Similarly, photographs—which are often included in application materials in Germany—can be omitted, as they provide no relevant information on abilities or accomplishments.

Despite these conceptual advantages, anonymizing CVs and application materials may not always be a viable option—at least not for a large research centre in Germany.

One major challenge in creating identifier-free applications concerns official documents and publication lists. University transcripts and research output are central components of candidate evaluations, and removing identifiers is often not practicable.

At the same time, many elements of a CV can act as indirect proxies for social identities. Scholarships, for instance, may implicitly reveal gender, family income, or nationality, as can certain academic activities. A candidate who has founded a chapter of Women in High Performance Computing, or who lists a presentation at the Queer in Computational and Applied Mathematics (QCAM) workshop, may inadvertently reveal aspects of their identity. While not every case can be anticipated, it is worth discussing in advance what information should be removed or anonymized. Simply blanking out scholarships or activities is not a viable solution, as these provide valuable insight into a candidate's accomplishments. In many cases, the information can instead be partially anonymized or replaced with an equivalent description.

A similar challenge arises with educational background. Alma mater can indicate social status or nationality, particularly at the bachelor level. Many scientists are reluctant to remove this information from CVs, as it is often perceived as a key indicator of academic excellence. Nevertheless, PIs should critically assess what they truly learn from this information and determine how it should be evaluated in accordance with established selection criteria if it is not anonymized.

Therefore, the implementation of double-anonymized reviews should be accompanied by careful consideration of potential unintended consequences. Hiring criteria in both anonymized and non-anonymized reviews should be clearly defined with equity considerations in mind, and evaluation metrics should be established and shared with reviewers. The screening process itself should also be structured with care. For instance, reviewers might first examine CVs to separate candidates into suitable and unsuitable pools, while a second review stage could incorporate cover letters and other application materials that provide important context about circumstances affecting academic or professional trajectories.

A possible strategy to minimize bias activation is to evaluate publication lists and sample publications independently of one another and separately from the CV. To some degree, this approach may reduce opportunities for bias even when anonymization of the application package is not feasible. However, identifiers cannot realistically be removed from all components of application materials. Institutional applicant management platforms do not support this level of anonymization, and printing application packages for manual redaction is not only time-consuming but may also pose privacy concerns.

It is also important to recognize that interventions such as anonymization do not account for inequitable conditions and may inadvertently disadvantage candidates whose career trajectories deviate from conventional paths because of background, health, or life circumstances. For example, a doctoral student with a disability may take longer to complete their degree, a queer candidate may have temporarily interrupted their studies due to economic or personal challenges, and a young parent may have fewer publications following parental leave. In these cases, removing context does not necessarily level the playing field and may unintentionally penalize individuals.

Cover letters

Cover letters typically accompany a CV and allow candidates to introduce themselves, articulate their interest in a position, and highlight relevant experiences. They are also commonly used to contextualize gaps in a CV, for example periods of reduced productivity due to personal or family circumstances. This makes it important for PIs to consider in advance how information from cover letters should inform candidate assessments, particularly when such materials include sensitive personal context.

In practice, cover letters are often used during the initial screening stage to filter out applicants under the assumption that they reliably signal genuine interest and professionalism. This assumption, however, deserves scrutiny, particularly in an era in which cover letters can be drafted or refined with artificial intelligence. Unless applicants are explicitly required to provide substantive materials within the cover letter itself—such as research statements, teaching concepts, or leadership visions—the extent to which these documents yield meaningful additional information remains unclear. Moreover, much of the information they are intended to convey could potentially be collected through more structured, consistent, and equitable assessment methods.

One major concern regarding the use of cover letters in candidate evaluations is their potential to trigger bias. While cover letters can offer useful context for gaps or irregularities in a CV, they may also contain explicit references to personal circumstances—for example, a period of reduced productivity due to health issues or a difficult pregnancy. Writing style and language use can likewise reveal, or be interpreted as revealing, gender, cultural background, or other aspects of applicant identity, which may inadvertently activate biases. He and Kang (2021), for instance, showed that women anticipating discrimination in male-dominated industries often adopted more masculine language in their cover letters as a protective strategy—yet were penalized for this mismatch between presumed identity and writing style, receiving fewer job offers on average. In other words, candidates may be unconsciously disadvantaged simply for failing to conform to gendered expectations about communication. Relying on cover letters as indicators of "motivation" or "interest" introduces additional problems. The ability to craft a polished narrative is unevenly distributed: candidates with limited writing support or differing linguistic and cultural backgrounds may be at a systematic disadvantage. These disparities bear little relationship to scientific competence or potential future performance. As a result, committees may inadvertently reward writing fluency and cultural homogeneity rather than actual qualifications.

Academic CVs generally provide sufficiently detailed information for assessing whether candidates meet the essential criteria for a position. If cover letters are to be used, PIs should first articulate what they expect to learn from them and why this information is necessary for the selection process. In many cases, targeted and standardized forms can replace open-ended letters and reduce opportunities for bias activation. For example, PIs may ask candidates whether there are any circumstances they would like to highlight that affect the interpretation of their CV—framed in broad, privacy-respecting

terms. Likewise, if research, teaching, or lab concepts are required, these can be requested through structured prompts that elicit directly relevant information without inviting unnecessary disclosure or subjective interpretation.

Evaluation committees

While ensuring gender balance in evaluation committees is a popular intervention to mitigate bias in academia, there is limited evidence that increasing the representation of women on hiring panels alone reliably reduces bias against female applicants. As gender stereotypes are socially acquired, they can shape the evaluations of both women and men, sometimes to a similar degree. Therefore, while it is important for candidates to encounter a diverse selection panel—and while panel composition may reflect how power is distributed within an organization—it would be misleading to assume that diverse panels are inherently better equipped to make less biased hiring decisions (Bagues & Esteve-Volart, 2010; Moss-Racusin et al., 2012; Isaac et al., 2009).

In many cases, women and other minority employees are asked to join a selection panel simply to fill a "diversity quota". While well-intentioned, this strategy can backfire. Minority employees and women are often overburdened with service [4] and administrative assignments at the expense of their scientific productivity and well-being. Furthermore, if the selected employees hold lower-ranking positions compared to others on the committee, they may struggle to share feedback and perspectives that differ significantly from those of higher-ranking members.

For leadership positions in particular, candidates may also be asked to include diversity statements as part of their cover letters. These statements can help assess a candidate's ability to contribute to diversity, equity, and inclusion (DEI) in supervision, research, and service, while also signalling the culture of the organizational unit or institute and associated expectations for the future. However, when such statements are requested, corresponding evaluation criteria should be explicitly incorporated into assessment matrices.

Recommendation letters

Letters of support are frequently used to evaluate candidates applying for leadership positions in science and academia, but they may also be considered when hiring scientists at other career stages. In Germany, it is common for applicants to include employment reference letters ("*Arbeitszeugnisse*") from previous employment when applying for a new position.

PIs might view letters of recommendation and Arbeitszeugnisse as valuable materials for assessing a candidate's ability and reliability (this, for instance, is common practice in specific physicists' communities). However, basing assessments on the analysis of letters of recommendation is problematic due to their low predictive validity (Hunter & Hunter, 1984).

While letters of recommendation and Arbeitszeugnisse can verify a candidate's previous roles and responsibilities, using them to evaluate past performance or future potential is challenging. Ideally, these letters should be objective, fact-based assessments of ability. In practice, however, multiple factors influence the writing process, including the author's familiarity with the applicant, their relationship, frame of reference, and writing skills (Wright & Ziegelstein, 2004). Additionally, because candidates typically select their own references, letters often suffer from leniency bias (Aamodt, 1999), providing overtly positive evaluations even for mediocre candidates.

In Germany, Arbeitszeugnisse must be approved by the employee before finalization, and managers are prohibited from including

information that might impede future employment. Similarly, in countries such as the U.S., applicants often have the right to see recommendation letters, which discourages authors from providing negative details about performance.

Empirical evidence also reveals gender patterns in recommendation letters. In academia, letters written for women are more likely to contain doubt raisers and emphasize hard work or persistence rather than exceptional achievements, whereas letters for men more often highlight standout accomplishments (Madera et al., 2019; Schmader et al., 2007). For example, Dutt et al. (2016) found that female postdocs were about half as likely as their male counterparts to receive letters describing them as "excellent".

Although the use of recommendation letters in hiring processes is problematic, they can sometimes provide valuable information that helps hiring committees understand the specific contributions an individual might bring to their group. If a committee decides to use recommendation letters as a data source, attention should be paid to ensure that the letters contain information useful to the committee while minimizing potential biases.

McCarthy and Goffin (2009) tested different approaches to improve the validity of recommendation letters and found that relative percentile methods may provide a better alternative to traditional letters. In recent years, several universities have begun asking candidates to submit standardized recommendation forms instead of traditional letters. These forms typically include questions about the candidate's abilities. Recommenders are required to provide percentile evaluations, comparing the candidate to others with similar titles and experience. Recommenders are then asked to substantiate their assessments with practical examples, provided in a free-form box with a defined character range. To further limit the impact of biases in the selection process, some institutions ask candidates to request recommendation letters only after being shortlisted for a position. Alternatively, recommendation letters may be considered only in the final stages of the hiring process, once all other materials have been scored and evaluated.

Informal references

In science, it is not uncommon for hiring committees to receive applications from candidates within their professional networks. Candidates may be known to PIs or committee members for various reasons, including conference attendance, collaborations, paper reviews, previous work in the same group, or having shared the same thesis advisor. This familiarity often provides committee members with access to additional information—either first- or second-hand—beyond the official application. Committee members should refrain from sharing or considering such information during the hiring process. Informal references are often unverifiable by other members and can introduce significant biases, either in favour of or against specific individuals.

Under no circumstances should external individuals be contacted to obtain informal feedback about a candidate without the candidate's prior knowledge and explicit consent. This includes requests for background impressions, informal references, or any other form of unofficial assessment.

All information used in the selection process must be collected through formal and transparent procedures in accordance with applicable data protection and employment law provisions. The disclosure of a candidate's application status to third parties without authorization is not permitted. Accordingly, a candidate's participation in a selection process must remain confidential.

General mental ability tests

General mental ability (GMA) tests are standardized assessments designed to measure cognitive capabilities such as reasoning, problem-solving, learning ability, and comprehension. Although not commonly used in academic hiring, Bohnet (2016) suggests that GMA tests could serve as a tool to reduce bias in academic hiring, in particular. GMA tests have consistently demonstrated predictive value for job performance. A seminal meta-analysis by Schmidt and Hunter (1998), conducted for the U.S. Department of Labor, evaluated 19 selection procedures and found that GMA tests—particularly when combined with work samples, structured interviews, or integrity tests—exhibit the highest validity for predicting job and training performance, especially in mid-and high-complexity roles. More recently, Sackett et al. (2023) reviewed research from the past two decades and confirmed that GMA remains related to job performance, although the strength of this relationship is somewhat weaker than previously reported.

Despite their predictive validity, GMA tests, however, can have unintended adverse effects. Tests developed in one cultural or educational context may not predict performance equally well in another. This is due to differences in language, schooling, or cultural norms (Schmidt & Hunter, 1998; Sackett et al., 2023). Therefore, such tests might not be ideal for evaluating an international talent pool, such as applicants for research or IT positions. Furthermore, research has shown that GMA tests may disproportionately disadvantage ethnic minority candidates (Sackett et al., 2001; Schmidt, 2002; Ployhart et al., 2001; Guion, 2011). Neurodivergent individuals—such as those with ADHD, dyslexia, anxiety, or autism spectrum conditions—may also be disadvantaged in highly structured, time-limited cognitive assessments (Armstrong, 2017; Hilliard, 2025). While direct evidence is limited, it is a plausible concern that these candidates might underperform on certain subtests despite high ability, and their performance may not fully reflect their potential in academic roles requiring domain expertise.

To mitigate these limitations, as no selection element is free from biases, management science scholars suggest combining GMA tests with complementary assessment elements, such as work samples or structured interviews (Guion, 2011; Ployhart et al., 2001; Schmidt & Hunter, 1998; Sackett et al., 2023). PIs should carefully consider whether the benefits of including GMA tests outweigh their potential shortcomings, given the specifics of the positions to be filled.

Work samples

Work sample tests—where applicants are asked to perform tasks that closely mirror those required in the role—are widely regarded as one of the most valid predictors of future job performance (Hunter & Hunter, 1984; Reilly & Warech, 1993). While their use is relatively common in academic hiring, they are applied less systematically in administrative and technical units, where their adoption could be further strengthened.

In academic contexts, and depending on the level of seniority, applicants may be asked to submit writing samples such as publications, research statements, or sample project reports. Following an initial screening, additional assessment methods are often incorporated into the interview stage, including teaching simulations, presentations of previous work, research strategy talks, or topic-specific presentations, to more comprehensively evaluate candidates' competencies.

For administrative and technical roles, analogous approaches can be implemented by asking candidates to complete practical assignments tailored to the position, such as data analysis tasks, project planning exercises, or problem-solving scenarios.

Results from a more recent meta-analysis by Roth et al. (2005) suggest that the relationship between work sample tests and future job performance may be more moderate than previously assumed. Nevertheless, work sample tests remain an effective tool for decision-making during the selection process. Furthermore, unlike general mental ability tests, they tend to show smaller subgroup differences and may therefore be less likely to disadvantage applicants from minority groups (Schmitt & Mills, 2001). Their value may be further enhanced when work samples are reviewed independently of CVs, recommendation letters, and cover letters, as this reduces exposure to contextual cues that may activate bias. However, it is important to recognize that anonymization of work samples is often not feasible in academic settings, where authorship is typically directly identifiable through publications. Therefore, while decoupling the review of materials may help to minimize bias activation, authorship may still remain visible and continue to influence evaluations.

Interviews: the final stage of the selection process

Interviews are a central component of most academic hiring processes, often serving as the primary opportunity for committees or PIs to assess a candidate beyond their written materials. However, the effectiveness of interviews depends heavily on their structure: while some formats can support fairer and more accurate evaluations, others introduce substantial bias and inconsistencies.

The effectiveness of unstructured interviews has been discredited by several studies (for an overview, see Dana et al., 2013; Levashina et al., 2014). In unstructured interview settings, interviewers tend to rely—often unconsciously—on random, irrelevant cues (noise) when evaluating candidates.

Initial impressions frequently go unchallenged because interviewers avoid asking questions that might contradict their intuitions, instead favouring those that confirm them. This sensemaking process, combined with confirmation bias, increases interviewers' confidence in their own judgments. However, confidence does not equate to accuracy: interviewers often feel certain about evaluations that largely reflect biased interpretations rather than valid assessments of candidate quality (Dana et al., 2013).

Management research overwhelmingly demonstrates the superiority of structured interviews over unstructured ones. By minimizing opportunities for bias activation, structured interviews provide more reliable and valid assessments of candidates, particularly when used alongside other selection elements. They are also less likely to disadvantage candidates from minority backgrounds or candidates with disabilities. Consequently, moving away from unstructured interviews is not only a matter of improving predictive accuracy but also a matter of fairness and social justice (Dana et al., 2013; Levashina et al., 2014; Bohnet, 2016; Brecher et al., 2006).

For practical reasons, interviews are often conducted in a semi-structured format, particularly in scientific settings where it may be necessary to tailor specific questions to a candidate's research background in order to meaningfully assess their expertise. While standardizing overarching questions related to the competencies being assessed is both possible and advisable, the precise wording of follow-up questions may need to vary depending on candidates' expertise and scientific backgrounds. Therefore, a limited degree of flexibility may be appropriate in practice. However, PIs are advised to maintain interviews as close as possible to a structured format and to minimize unnecessary variation in interview content and procedures.

In academic and research environments, interviews often follow recurring patterns that introduce some degree of structure and

comparability. Candidates are typically asked to deliver a technical presentation (serving as a work sample), followed by topic-relevant questions to assess their expertise. Additional questions may address the proposed research project, its implementation and feasibility, and its broader impact, as well as more general topics such as candidates' experience working in interdisciplinary teams, their ability to collaborate effectively, and their resilience, among other relevant aspects.

Hiring committees, depending on the seniority of the candidates, use this process to evaluate a range of competencies, including technical expertise, communication skills, critical thinking, and self- and project management abilities, as well as the ability to work in a team and the capacity to engage in potentially challenging discussions about one's own work. For more senior candidates in particular, interviews also serve to assess a candidate's ability to articulate a coherent research vision, demonstrate the societal relevance and broader impact of their work, show that they can lead a team, and position their research within wider academic or applied contexts.

The validity of interviews depends on the extent to which discretion is systematically constrained and anchored in predefined, job-relevant selection criteria. This requires the development of clearly specified competency dimensions, corresponding interview questions, a predetermined sequence of questions, clearly allocated responsibilities among interviewers, standardized evaluation rubrics, and appropriate training for committee members in the use of the interview procedure and assessment elements. During the interview, all candidates should be assessed against the same competency dimensions, asked the same core questions in the same order, and evaluated according to the same criteria.

Where multiple interviewers are involved, each competency block should ideally be assigned to the same interviewer across all candidates. Follow-up questions may be used where necessary to clarify, verify, or elicit more detailed information, but interviewer discretion and spontaneous deviation from the interview protocol should be kept to an absolute minimum.

Bohnet (2016) further recommends scoring responses immediately after each question, directly during the interview, rather than retrospectively after the interview has concluded.

Where a committee is involved, members should refrain from discussing candidates until the full interview cycle has concluded, thereby limiting the influence of groupthink. Interviewers should submit their scores before any panel discussion begins.

As noted earlier, comparisons between candidates should be conducted horizontally—question by question—rather than vertically, candidate by candidate. This approach allows performance to be evaluated across the full range of relevant criteria and domains. Since candidates often excel in some areas while performing more moderately in others, this method supports a more balanced overall assessment and helps avoid the impression that a candidate performs strongly across all dimensions when they may in fact excel only in specific areas.

Extending an offer

There is extensive evidence documenting gender pay disparities. While the gap varies by country and industry, in most cases, women earn a fraction of what their male counterparts earn (Bohnet, 2016). According to the Federal Statistical Office of Germany, women in Germany consistently earn less than men across all sectors

and responsibility levels. In 2024, women earned, on average, 16% less than men. This gap increases at higher management levels, where women earned almost 21% less than men. Several factors shape the gender pay gap, including managerial responsibilities, industry, education, experience, role, location, and employer. Nevertheless, even after adjusting for these variables, the equity gap in Germany last year remained at 6%. In other words, women earned on average 94 cents for every euro a man earned. While a 6 cent gap might appear small, it compounds over time into hundreds or thousands of euros. Data from other countries show that the gap is often higher for individuals belonging to two or more marginalized groups (e.g. Tucker, 2022; Anderson, 2020).

Inadmissible questions

The German General Act on Equal Treatment (AGG) prohibits questions relating to the following protected characteristics:

- Ethnic origin
- Religion or belief
- Gender identity or sexual orientation
- Family planning, pregnancy, or intention to have children
- Age or pension status
- Ideology or worldview
- Health status or disability
- Trade union membership or political affiliation
- Financial circumstances

Questions in these areas are not permitted, whether asked directly or indirectly.
Examples include, but are not limited to:

- Where do you originally come from?”
- “Do you practice a religion?” or “Which religion do you belong to?”
- “Are you planning to have children?” or “Do you have children?”
- “How old are you?” (unless strictly required for eligibility purposes)
- “Do you have any health issues we should know about?”
- “Are you a member of a political party or trade union?”
- “How is your financial situation?”

Such questions must not be asked in formal interviews. This also applies to informal or semi-formal settings, such as lunches or other interactions outside the structured interview process.
Inadmissible questions must not be used in evaluation. Candidates are not obliged to provide truthful responses, and such questions may compromise the fairness and legal validity of the selection process.

In Germany, salaries for most academic positions and positions in universities and research centres are regulated through collective bargaining agreements (e.g. TVöD or TV-L). It may therefore be tempting to assume that the gender pay gap is not relevant under such circumstances. Inequality, however, might also arise beyond mere compensation. New hires, for example, may still be able to negotiate benefits, working time, employment conditions, entry packages, or early-career expectations and trajectories. These are highly relevant in shaping earning and future career opportunities. In these contexts, hidden bias, as well as gender- or culture-coded behaviour, may influence final outcomes. Several studies, for instance, show that women are less likely to negotiate proactively and, when they do, are often penalized for doing so (see Bowles et al., 2007; Reif et al., 2020; Mazei et al., 2015).

Similar dynamics can arise where collectively agreed salary structures are not applied. This is particularly relevant for scientists in managerial positions—especially institute directors and W professors. They often negotiate contracts, performance goals, bonuses, start-up funds, space, and additional benefits outside collective bargaining agreements. In these cases, the potential effects of bias, as well as culturally and gender-coded negotiation behaviour, should be acknowledged by hiring committees and discussed.

Mazei et al. (2015; 2019), Amanatullah (2010), and Reif et al. (2019) indicate that contextual factors—such as built-in negotiation opportunities after a job offer, transparent pay ranges, negotiation experience, and whether a person is negotiating for themselves or for others—significantly shape women's willingness to negotiate and the outcomes achieved. Following these insights, candidates receiving an offer should be informed transparently about pay ranges, benefits, and —where applicable—start-up packages. They should be explicitly invited to discuss their offer, and it should be made clear which elements are negotiable and to what extent. These range from job classification and pay group assignment known as "Eingruppierung" (which are hardly negotiable) to more flexible work-life balance arrangements, working hours, training needs, and relocation support [2]. Mazei et al. (2015; 2019), Amanatullah (2010), and Transparent communication about negotiable elements and institutional limits helps ensure that offers are perceived as fair and equitable.

In this context, one of the most important measures that institutes can employ is systematic self-monitoring. Data collection is essential to identify structural disparities and to ensure equitable working conditions. Pay gap analyses should include bonuses, target agreements, and access to benefits. Ideally, start-up packages and lab space allocations should also be monitored, while accounting for discipline-specific differences in infrastructure and staffing needs, and research costs.

Notes

[1] People with a recognized severe disability (Schwerbehinderten) in Germany are protected by labor laws. While it can be beneficial to remove information about a candidate's disability from their CV to minimize bias, it is important to remember that candidates with a recognized disability of 40% or higher are legally entitled to be interviewed for the position.

[2] When extending an offer, it is essential that PIs do not communicate salary expectations or employment conditions that cannot be formally implemented. As QuGrids positions are subject to the TVöD or TV-L framework and are assigned

to predefined pay groups, there is limited flexibility in the basic classification of a role. However, certain aspects may allow for case-by-case consideration, including the recognition of relevant professional experience when determining the experience level, and, where applicable, the use of additional measures such as recruitment allowances.

Tables

PERCENTAGE OF WOMEN AMONG STEM GRADUATES BACHELOR'S AND MASTER'S PROGRAMMES (SELECTED EU COUNTRIES)

	NATURAL SCIENCES, MATHEMATICS AND STATISTICS		INFORMATION AND COMMUNICATION TECHNOLOGIES		ENGINEERING, MANUFACTURING AND CONSTRUCTION	
	Bachelor's graduates	**Master's graduates**	**Bachelor's graduates**	**Master's graduates**	**Bachelor's graduates**	**Master's graduates**
EU - 27	**56%**	**54%**	**21%**	**25%**	**26%**	**33%**
BELGIUM	41%	48%	13%	17%	23%	29%
BULGARIA	69%	72%	35%	40%	25%	33%
CZECHIA	62%	64%	17%	21%	33%	35%
DENMARK	56%	56%	18%	38%	25%	37%
GERMANY	**50%**	**53%**	**21%**	**23%**	**19%**	**27%**
ESTONIA	68%	64%	26%	39%	28%	33%
GREECE	55%	50%	31%	41%	33%	43%
SPAIN	53%	48%	14%	23%	29%	37%
FRANCE	55%	51%	17%	21%	28%	29%

Table 1: Percentage of women among STEM graduates from bachelor's and master's programmes in different European countries (2018). Source: She Figures 2021.

DOCTORAL GRADUATES (2021)

	PHYSICS & ASTRONMY			**ELECTRICITY & ENERGY AND ELECTRONICS & AUTOMATION**			**INFORMATICS**		
	Women		**Men**	**Women**		**Men**	**Women**		**Men**
EU - 27	**1265**	**26%**	**3540**	**843**	**21%**	**3179**	**755**	**23%**	**2581**
BELGIUM	7	18%	32	6	15%	33	1	8%	12
BULGARIA	6	50%	6	21	31%	47	14	39%	22
CZECHIA	19	29%	47	9	10%	77	14	18%	64
DENMARK	0		0	0		0	0		0
GERMANY	**353**	**21%**	**1329**	**122**	**14%**	**735**	**199**	**20%**	**809**
ESTONIA	3	75%	1	0	0%	3	10	38%	16
IRELAND	12	43%	16	2	25%	6	28	35%	52
GREECE	18	29%	45	20	22%	73	18	22%	64
SPAIN	102	27%	273	89	20%	367	56	23%	191
FRANCE	340	28%	883	227	27%	620	190	26%	543
CROATIA	4	27%	11	5	16%	27	2	67%	1
ITALY	181	31%	409	141	22%	499	55	28%	139
CYPRUS	2	100%	0	1	20%	4	0	0%	5

LATVIA	5	50%	5	1	11%	8	4	57%	3
LITHUANIA	3	21%	11	1	5%	20	5	63%	3
LUXEMBOURG	2	22%	7	0		0	9	23%	30
HUNGARY	12	26%	34	1	6%	15	13	17%	62
MALTA	0		3	0		0	0	0%	2
NETHERLANDS	:		:	0		0	17	14%	103
AUSTRIA	27	21%	99	16	18%	73	13	13%	87
POLAND	38	36%	68	22	23%	73	7	12%	51
PORTUGAL	11	18%	49	20	22%	69	7	11%	54
ROMANIA	18	49%	19	38	24%	120	18	35%	34
SLOVENIA	:		:	0		0	3	15%	17
SLOVAKIA	19	45%	23	6	15%	33	3	11%	24
FINLAND	17	27%	46	23	22%	82	29	21%	111
SWEDEN	54	33%	112	72	27%	192	40	33%	82
ICELAND	2	40%	3	0	0%	2	:		:
LIECHTENSTEIN	0		0	0		0	:		:
NORWAY	4	20%	16	6	19%	26	:		:
SWITZERLAND	56	25%	169	56	24%	175	:		:
UNITED KINGDOM	:		:	0		0	:		:
BOSNIA AND HERZEGOVINA	:		:	0	!	0	:		:
MONTENEGRO	0		0	0	0%	2	:		:
NORTH MACEDONIA	0		0	2	67%	1	5	31%	11
ALBANIA	1	50%	1	8	57%	6	10	71%	4
SERBIA	10	53%	9	14	29%	34	6	27%	16
TÜRKIYE	50	36%	87	99	19%	428	:		:

Table 2: Doctoral degrees in physics, electricity & energy, and electronics & automation, and informatics across different countries in 2021. While Germany is below the EU average in terms of the representation of women in these areas, it still produces a substantial proportion of women doctoral graduates. In 2021, Germany, France, Italy, and Spain together accounted for 77% of all women who obtained a doctoral degree in Europe and 68.8% of those who earned a doctoral degree in electricity & energy and electronics & automation. Source: She Figures 2021.

PHYSICS AND ASTRONOMY

	Bachelor's degree				Master's degree		Doctoral degree	
	Entrants	Women	Graduates	Women	Graduates	Women	Graduates	Women
2010	5519	21%	1396	21%	184	23%	1408	18%
2011	7318	19%	2168	19%	487	22%	1520	20%
2012	6569	24%	2450	22%	930	20%	1582	20%
2013	6954	24%	2523	19%	1,688	21%	1767	20%

2014	6642	25%	3138	17%	2,174	21%	1727	19%
2015	7155	26%	3157	18%	2,362	21%	1926	19%
2016	7558	29%	3049	20%	2,559	19%	1790	19%
2017	7836	29%	2835	20%	2,937	19%	1794	22,5%
2018	7800	30%	2741	21%	2,805	20%	1850	20%
2019	7786	31%	2886	23%	2,784	22%	1743	21%
2020	6989	30%	2429	24%	2,602	21%	1607	23%
2021	6925	30%	2864	25%	2,700	23%	1682	21%
2022	6990	31%	2676	26%	2,694	26%	1693	22%
2023	7184	33%	2601	26%	2,638	26%	1567	23%

Table 3: The table above presents the number of bachelor's, master's, and doctoral degrees awarded by gender in each year, as well as the number of students enrolled in bachelor's programmes in physics and astronomy. The percentage of women enrolling in physics programmes rose significantly over the years. However, there has been little corresponding improvement in the proportion of women earning master's and doctoral degrees in physics. Source: Competence Center Technology-Diversity-Equal Opportunities.

ELECTROTECHNICS AND INFORMATION

	Bachelor's degree				**Master's degree**		**Doctoral degree**	
	Entrants	**Women**	**Graduates**	**Women**	**Graduates**	**Women**	**Graduates**	**Women**
2010	13733	10%	3333	8%	1339	14%	656	8.5%
2011	16963	10%	5269	8%	2030	11%	712	10%
2012	16029	12%	6184	9%	2683	11%	708	12%
2013	16243	12%	6999	9%	3509	11%	731	10%
2014	14970	14%	7373	9%	4409	11%	731	14%
2015	14,649	14%	8055	9%	5220	12%	892	13%

2016	14227	15%	7829	10%	5577	13%	846	13%
2017	13855	15%	7641	10%	6173	13%	795	13%
2018	13570	16%	7390	11%	6359	13%	819	13%
2019	12865	16%	7043	12%	6385	15%	833	15%
2020	11302	15%	6214	13%	5766	16%	784	17%
2021	10598	16%	6602	13%	5912	16%	833	14%
2022	11113	17%	6483	13%	5814	17%	769	14%
2023	10727	18%	6268	13%	5773	18%	770	14%

Table 4: The table above presents the number of bachelor's, master's, and doctoral degrees awarded by gender in each year, along with the number of students enrolled in bachelor's programmes in electrotechnics and information. Over the observed period, the number of women students enrolling in bachelor's programmes gradually increased. A modest rise in the proportion of women earning bachelor's, master's, and doctoral degrees can also be observed. Nevertheless, female representation remains strikingly low across all academic levels, highlighting a persistent gender imbalance in these fields. Source: Competence Center Technology-Diversity-Equal Opportunities.

INFORMATICS

		Bachelor's degree			**Master's degree**		**Doctoral degree**	
	Entrants	**Women**	**Graduates**	**Women**	**Graduates**	**Women**	**Graduates**	**Women**
2010	22666	19%	8463	19%	2198	24%	832	14%
2011	28033	20%	10497	19%	3087	15%	902	13%
2012	28012	22%	12077	21%	4143	15%	885	13%
2013	28877	23%	12621	21%	5115	15%	941	18%
2014	30589	24%	14063	21%	5991	16%	994	15%
2015	31934	25%	15484	22%	6926	17%	1103	14%
2016	33443	25%	15529	22%	7787	18%	1021	15%
2017	34013	25%	15933	22%	8803	19%	973	16%

2018	35017	22%	16325	22%	9444	20%	873	16%
2019	35083	22%	17437	21%	9937	22%	1032	16%
2020	34391	22%	17862	21%	9814	23%	858	17%
2021	34560	22%	19746	21%	11092	23%	910	18%
2022	36162	24%	20814	24%	12151	24%	1008	20%
2023	38211	25%	20946	25%	12346	26%	1004	21%

Table 5: The table above presents the number of bachelor's, master's, and doctoral degrees awarded by gender each year, along with the number of students enrolled in bachelor's programmes in informatics. Over the observed period, the number of women students enrolling in bachelor's programmes and graduating from master´s programmes gradually increased. A modest rise in the proportion of women earning bachelor's and doctoral degrees can also be observed. Nevertheless, female representation remains strikingly low across all academic levels, highlighting a persistent gender imbalance in these fields. Source: Competence Center Technology-Diversity-Equal Opportunities.

Figures

Physics and astronomy

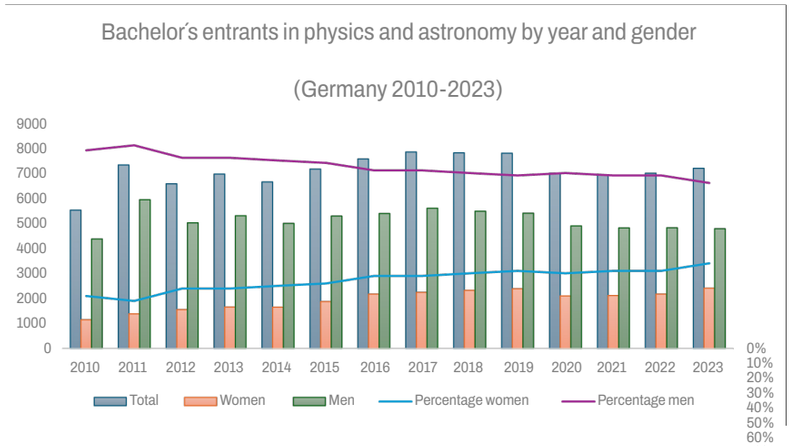


Figure 1: Physics and astronomy bachelor entrants by gender (2010–2023). Efforts to recruit more women in physics and astronomy programmes seem to have led to a slight increase in the number of women over the years. Source: Competence Center Technology-Diversity-Equal Opportunities.

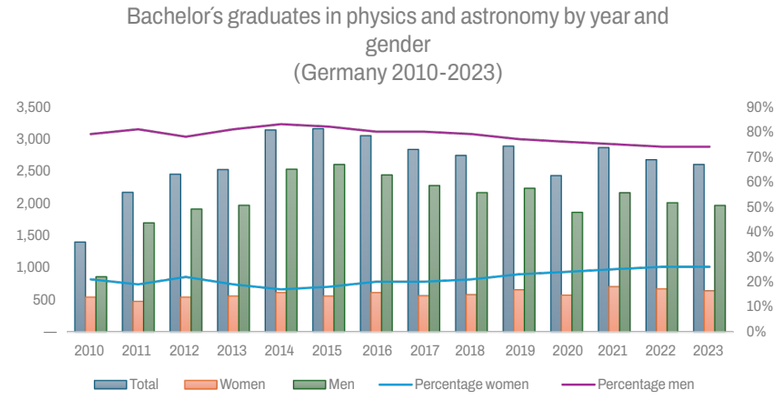


Figure 2: Physics and astronomy bachelor's graduates by gender (2010–2023). Over the years, there was a mild increase in the number of women graduating from bachelor's programmes in physics and astronomy. Source: Competence Center Technology-Diversity-Equal Opportunities.

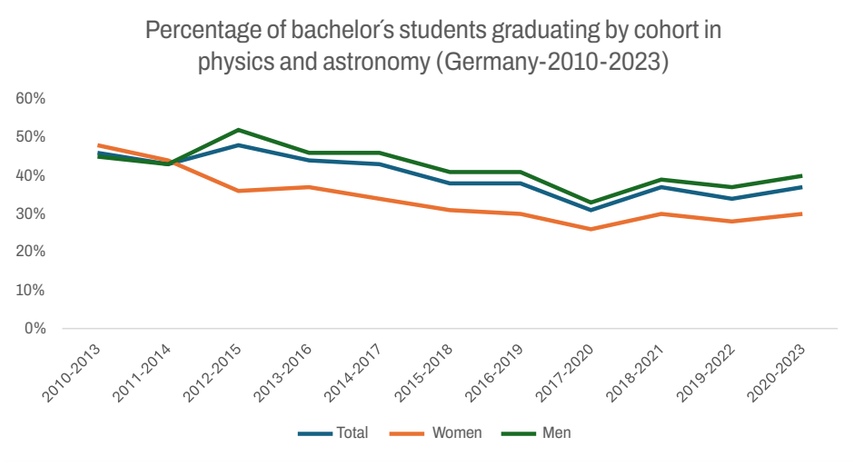


Figure 3: Percentage of bachelor´s students graduating by cohort in physics and astronomy (Germany-2010-2023). For most cohorts, the percentage of students graduating within four years is lower among women. Source: Competence Center Technology-Diversity-Equal Opportunities.

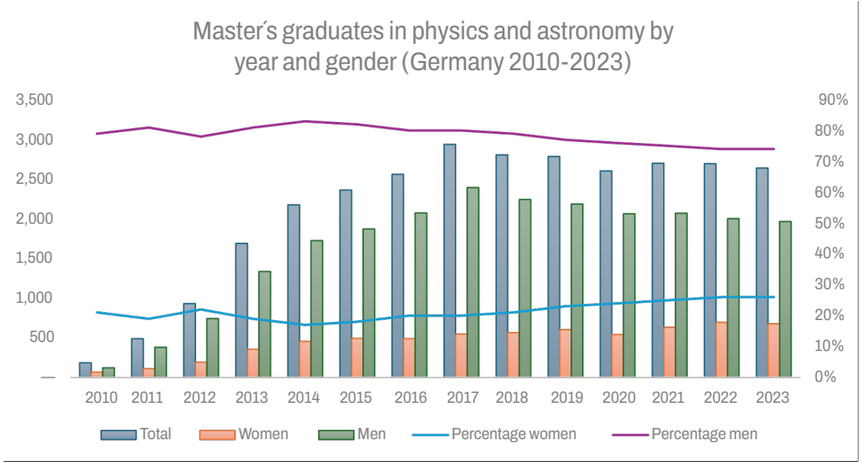


Figure 4: Master's graduates in physics and astronomy by gender (Germany: 2010–2023). The proportion of women among graduates from master's programmes mildly increased over the years. Nevertheless, the representation of women remained low. Source: Competence Center Technology-Diversity-Equal Opportunities.

Electrotechnics and information

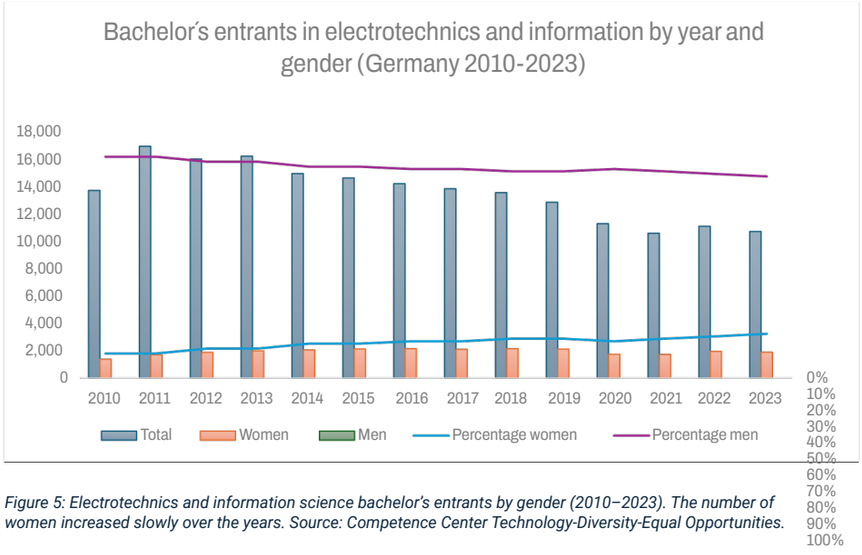


Figure 5: Electrotechnics and information science bachelor's entrants by gender (2010–2023). The number of women increased slowly over the years. Source: Competence Center Technology-Diversity-Equal Opportunities.

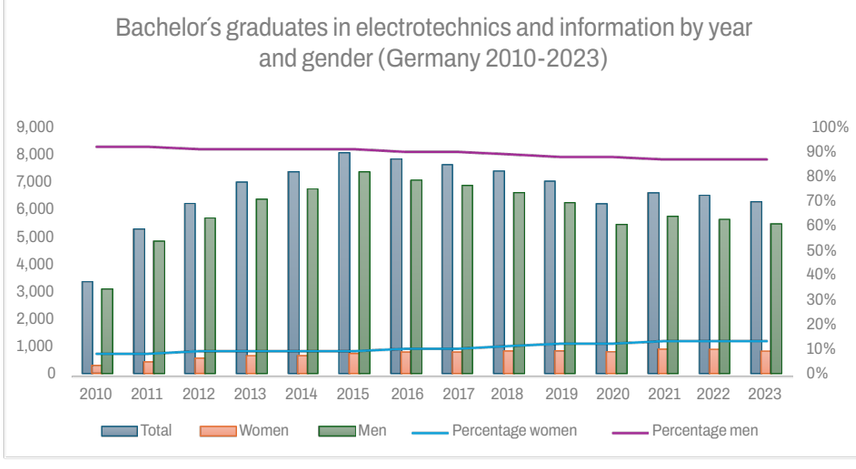


Figure 6: Bachelor´s graduates in electrotechnics and information by year and gender (Germany 2010-2023). Graduation rates remained lower for women (in some cycles, fewer than one in five women graduated; for men, fewer than one in four in the worst cycle). Source: Competence Center Technology-Diversity-Equal Opportunities.

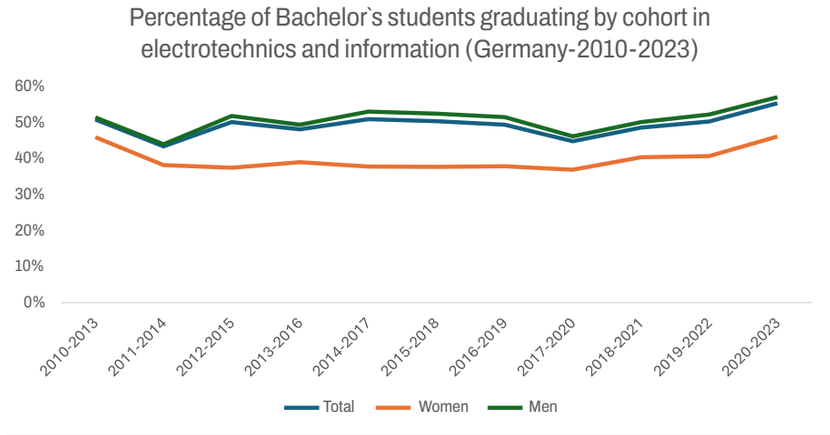


Figure 7: Percentage of Bachelor`s students graduating by cohort in electrotechnics and information (2010–2023). The proportion of bachelor's students graduating from electrotechnics and information programmes within four years remained lower for women than for men across all cohorts. Source: Competence Center Technology-Diversity-Equal Opportunities.

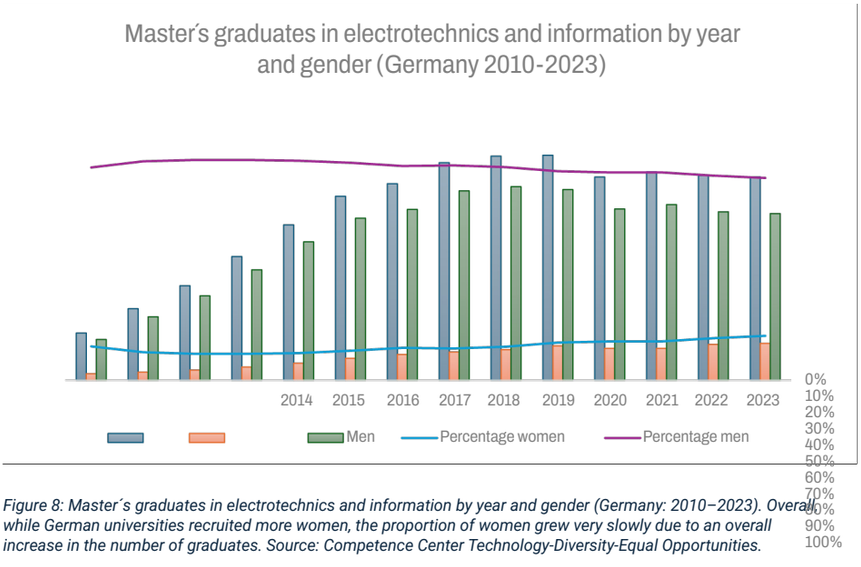


Figure 8: Master´s graduates in electrotechnics and information by year and gender (Germany: 2010–2023). Overall, while German universities recruited more women, the proportion of women grew very slowly due to an overall increase in the number of graduates. Source: Competence Center Technology-Diversity-Equal Opportunities.

Informatics

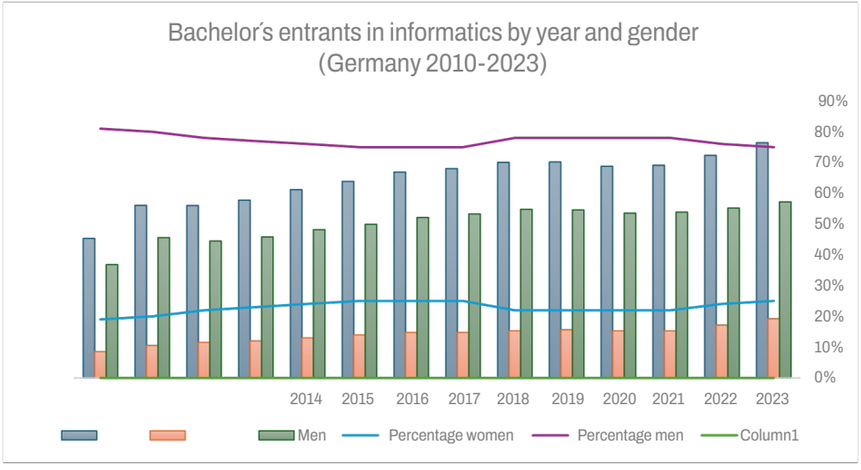
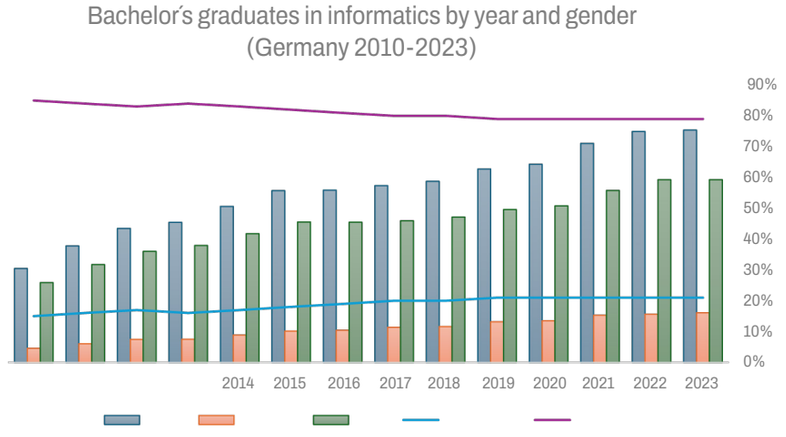


Figure 9: Bachelor's entrants in informatics by gender (2010–2023). The proportion of women gradually increased over the years; however, the overall percentage of women enrolling in bachelor's programmes in informatics remained low due to rising total enrolment numbers. Source: Competence Center Technology-Diversity-Equal Opportunities.



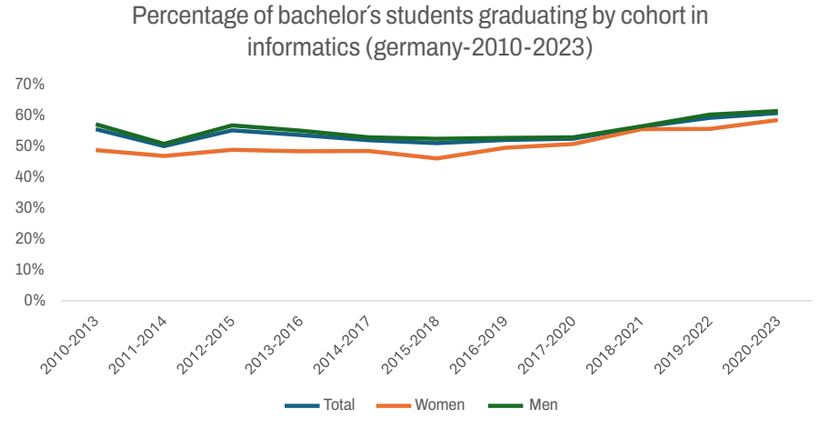


Figure 11: Percentage of Bachelor´s students graduating by cohort in informatics (2010–2023). The percentage of bachelor's students graduating from informatics programmes within four years remained slightly lower for women than for men across most cohorts. Source: Competence Center Technology-Diversity-Equal Opportunities.

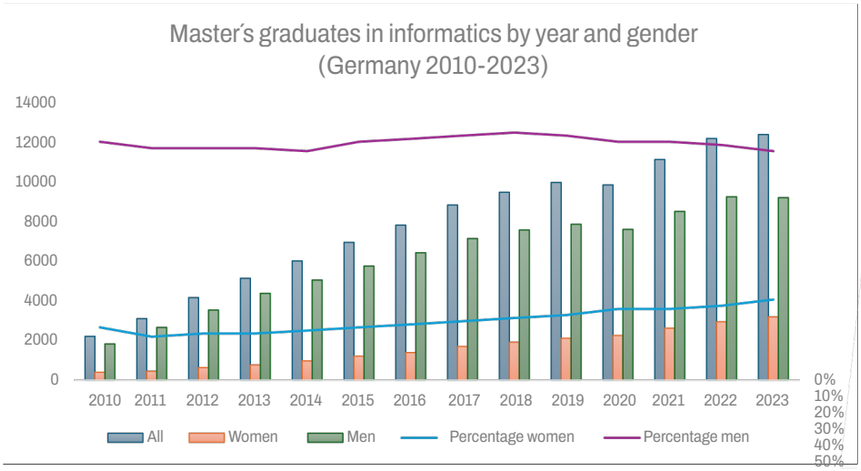


Figure 12: Master´s graduates in informatics by year and gender (Germany: 2010–2023). Overall, while German universities recruited more women, the proportion of women grew very slowly due to the overall increase in the number of students. Source: Competence Center Technology-Diversity-Equal Opportunities.

Glossary

Allgemeines Gleichbehandlungsgesetz (AGG): The Allgemeines Gleichbehandlungsgesetz (AGG), or General Equal Treatment Act, is a German federal law that has been in force since 18 August 2006. It aims to prevent and eliminate discrimination on the grounds of race, ethnic origin, gender, religion or belief, disability, age, or sexual identity. The AGG protects individuals both in the workplace and in everyday civil law transactions.

Discrimination: The Allgemeines Gleichbehandlungsgesetz (AGG) defines discrimination as the unjustified, less favourable treatment of a person based on race/ethnic origin, gender, religion/belief, disability, age, or sexual identity. It prohibits both direct discrimination (explicit disadvantages) and indirect discrimination (neutral rules with discriminatory effects).

Diversity: According to the European Institute for Gender Equality "diversity" refers to "differences in the values, attitudes, cultural perspective, beliefs, ethnic background, sexual orientation, gender identity, skills, knowledge and life experiences of each individual in any group of people".

Diversity dimensions: Diversity dimensions refer to the visible and invisible characteristics that differentiate individuals or groups within society. Some of these characteristics, such as age or ethnic origin, are fixed and cannot be changed. Others, including education or socio-economic status, are more dynamic and may evolve over time. The Charta der Vielfalt, a German employer initiative that promotes diversity and inclusion in the workplace, identifies seven core diversity dimensions: age, ethnic origin and nationality, gender identity, physical and mental abilities, religion or belief, sexual orientation, and social origin.

Equality: Equality is the principle of equal rights and equal treatment. In Germany, equality is anchored in the Grundgesetz. Article 3(1) establishes that all persons are equal before the law. Article 3(2) guarantees the equality of men and women and obliges the state to promote the actual implementation of equal rights and to eliminate existing disadvantages. Article 3(3) further prohibits discrimination or preferential treatment on the grounds of sex, parentage, race, language, homeland and origin, faith, religious or political opinions, and disability.

This constitutional principle is further specified by the Allgemeines Gleichbehandlungsgesetz (AGG), which provides protection against discrimination in employment and civil law on the grounds of sex, ethnic origin, religion or belief, disability, age, and sexual orientation.

Equity: While equality focuses on equal treatment and sameness, equity recognizes individual and systemic disadvantages and allocates resources to promote fairness.

Fairness: Fairness denotes the achievement of equitable outcomes by ensuring that individuals have access to resources and opportunities in accordance with their specific needs. It is not a matter of treating everyone identically, but rather of removing structural and individual barriers that hinder full participation and success within society.

Gender: According to the European Institute for Gender Studies, the word "gender refers to the social attributes and opportunities associated with being female and male and to the relationships between women and men and girls and boys, as well as to the relations between women and those between men. These attributes, opportunities and relationships are socially constructed and are learned through socialisation processes. They are context- and time-specific, and changeable.

Gender determines what is expected, allowed and valued in a woman or a man in a given context. In most societies, there are differences and inequalities between women and men in responsibilities assigned, activities undertaken, access to and control over resources, as well as decision-making opportunities. Gender is part of the broader sociocultural context. Other important criteria for sociocultural analysis include class, race, poverty level, ethnic group and age."

Gender mainstreaming: The European Institute for Gender Equality (EIGE) defines gender mainstreaming as a strategy to achieve gender equality. It entails systematically incorporating a gender perspective into the planning, design, implementation, monitoring, and evaluation of policies, regulatory measures, and spending programmes with the aim of promoting equality and preventing discrimination. A practical example is the EU's Horizon Europe programme, which requires research projects to address gender-related aspects, illustrating how gender mainstreaming can be applied in research.

Inclusion: Inclusion is a deliberate effort to ensure that people with different backgrounds, needs and life experiences, have the resources and opportunities they need to participate fully in society, work effectively, and reach their full potential.

Intersectionality: The concept of intersectionality provides a framework for understanding how social identities relate to power. As multiple social identities overlap and intersect, they produce distinct experiences of inequality or privilege. For example, in our society, experiences related to gender are shaped by factors such as age, parental status, ethnic background, and social class.

Marginalized group: A marginalized group is a group of people who are fully or partially excluded—either directly or indirectly—from mainstream political, economic, and social life due to shared characteristics such as disability, religion, socioeconomic status, ethnic background, gender, or sexual orientation. Their access to resources, opportunities, and power is limited. For example, they may have little or no access to basic services such as housing, education, employment, or healthcare.

Marginalization, however, can also occur in more subtle ways. In the workplace, members of these groups might be seen as unsuitable for certain positions, stigmatized for not following expected social roles, or evaluated according to definitions of success that do not fit their needs. Development opportunities and support may also be designed without considering their circumstances, limiting their personal and professional growth.

Minority group: The term "minority group" is often used as a proxy for a marginalized group. However, "minority" does not necessarily refer to the numerical size of a group. Instead, it should be understood in terms of both the group's relative size within a given context and its access to power and resources.

Tokenism: Tokenism is the practice of making a symbolic effort to include minority individuals in an initiative, project, event, or programme without taking meaningful steps to create a genuinely inclusive environment. A typical example is inviting a woman to join a project not for her expertise or contributions, but solely to fulfil a gender representation implicit requirement.

Sex: According to the European Institute for Gender Studies, the word "sex refers to the biological and physiological characteristics that define humans as female or male. These sets of biological characteristics are not mutually exclusive, as there are individuals who possess both, but these characteristics tend to differentiate humans as females or males".

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