Promote FAIRness in EDUcations Institutions

Uncovering Gender Bias in Academia

Diana Di Marco, Francesca Marzi, Antinisca di Marco,

Andrea D'Angelo, Giordano D'Aloisio Giovanni Stilo

DISIM
Dipartimento di Ingegneria
e Scienze dell'Informazione
e Matematica

Università degli Studi dell'Aquila

Department of Information Engineering, Computer Science and Mathematics

Algorithmic Bias

- **b**ias **impacts individuals** or groups characterized by a set of **legally-protected** sensitive **attributes** (e.g., race, gender, religion, …);

- the **inequalities** might be **reinforced** by **Artifical Intelligence** System **can lead** to severe *discrimination* and *unfairness*;

COOKING

ROLE		VALUE
AGENT	▶	WOMAN
FOOD	▶	PASTA
HEAT	▶	STOVE
TOOL	▶	SPATULA
PLACE	▶	KITCHEN

COOKING

ROLE		VALUE
AGENT	▶	WOMAN
FOOD	▶	FRUIT
HEAT	▶	—
TOOL	▶	KNIFE
PLACE	▶	KITCHEN

COOKING

ROLE		VALUE
AGENT	▶	WOMAN
FOOD	▶	MEAT
HEAT	▶	GRILL
TOOL	▶	TONGS
PLACE	▶	OUTSIDE

COOKING

ROLE		VALUE
AGENT	▶	WOMAN
FOOD	▶	VEGETABLES
HEAT	▶	STOVE
TOOL	▶	TONGS
PLACE	▶	KITCHEN

COOKING

ROLE		VALUE
AGENT	▶	MAN
FOOD	▶	—
HEAT	▶	STOVE
TOOL	▶	SPATULA
PLACE	▶	KITCHEN

BIAS in AI
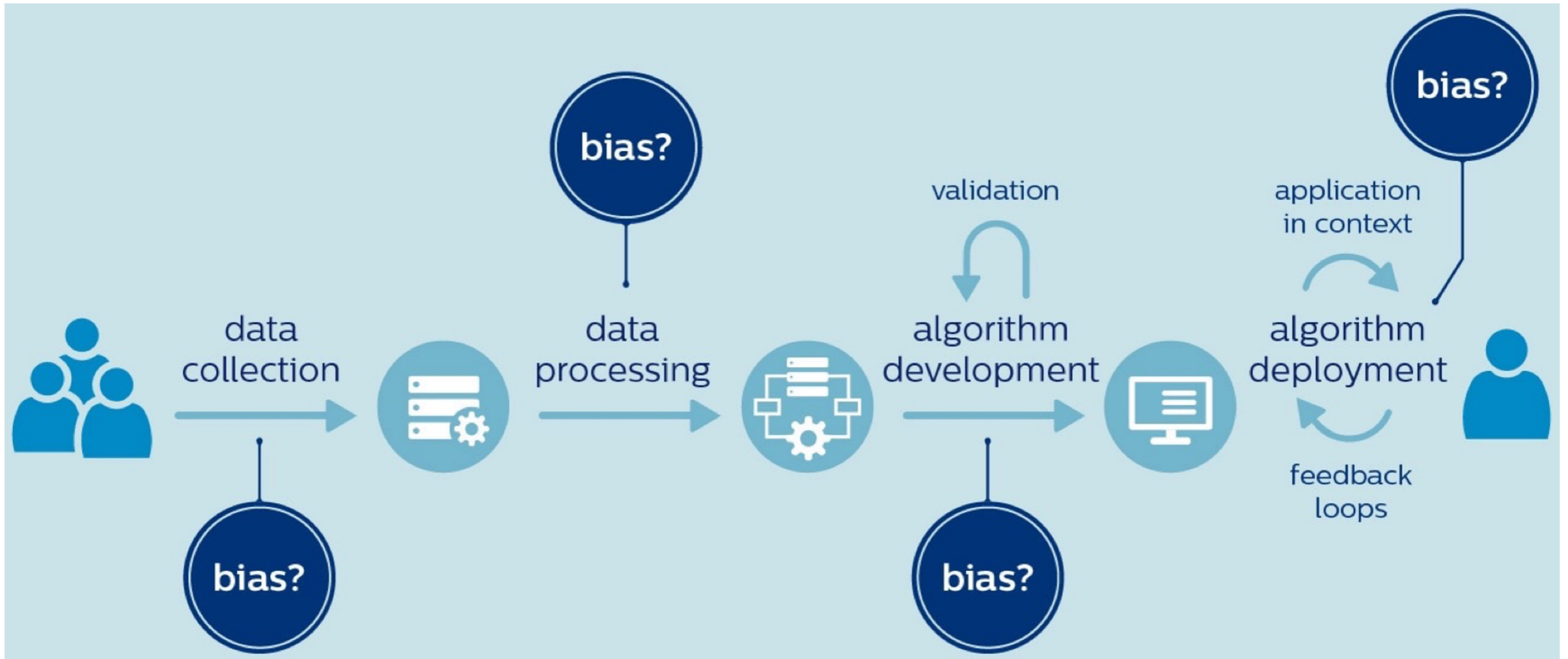
Algorithmic **B**ias study how to **measure** and **mitigate** the impact of the bias in/on **AI** systems.

GOALS

Mitigating Algorithmic Bias
is a ground step to reach the UN's SDG

5 GENDER EQUALITY

10 REDUCED INEQUALITIES

AI-GAP

FAIR-EDU: Uncovering Gender Bias in Academia

FAIR-EDU

FAIR-EDU Project

Want to **evaluate** and estimate the **algorithmic bias** present in the **staff-related data** generated and used by **Classic Educational Systems** with **special interest** to those of the University of L'Aquila.

MARCH 2022

GENDER EQUALITY PLAN
officially approved by "Board of Directors"

FAIR-EDU

accepted

JUNE/SEPT 2022

SETUP and START
project officially start by setting up phase

PROPOSAL
submitted UAQ scientific committee

DECEMBER 2021

MAY 2022

FAIR-EDU: Uncovering Gender Bias in Academia

Talk Overview

Literature Review

Data Gathering

Evaluation of the BIAS

Discussion

Identification of the literature

Critically analysis

Collecting data from Public sources

Measures:
- Network Analysis,
- Disparate Impact

- Where are the critical points?

01

02

03

04

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Phase One

Literature Review

01

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Studies Identification
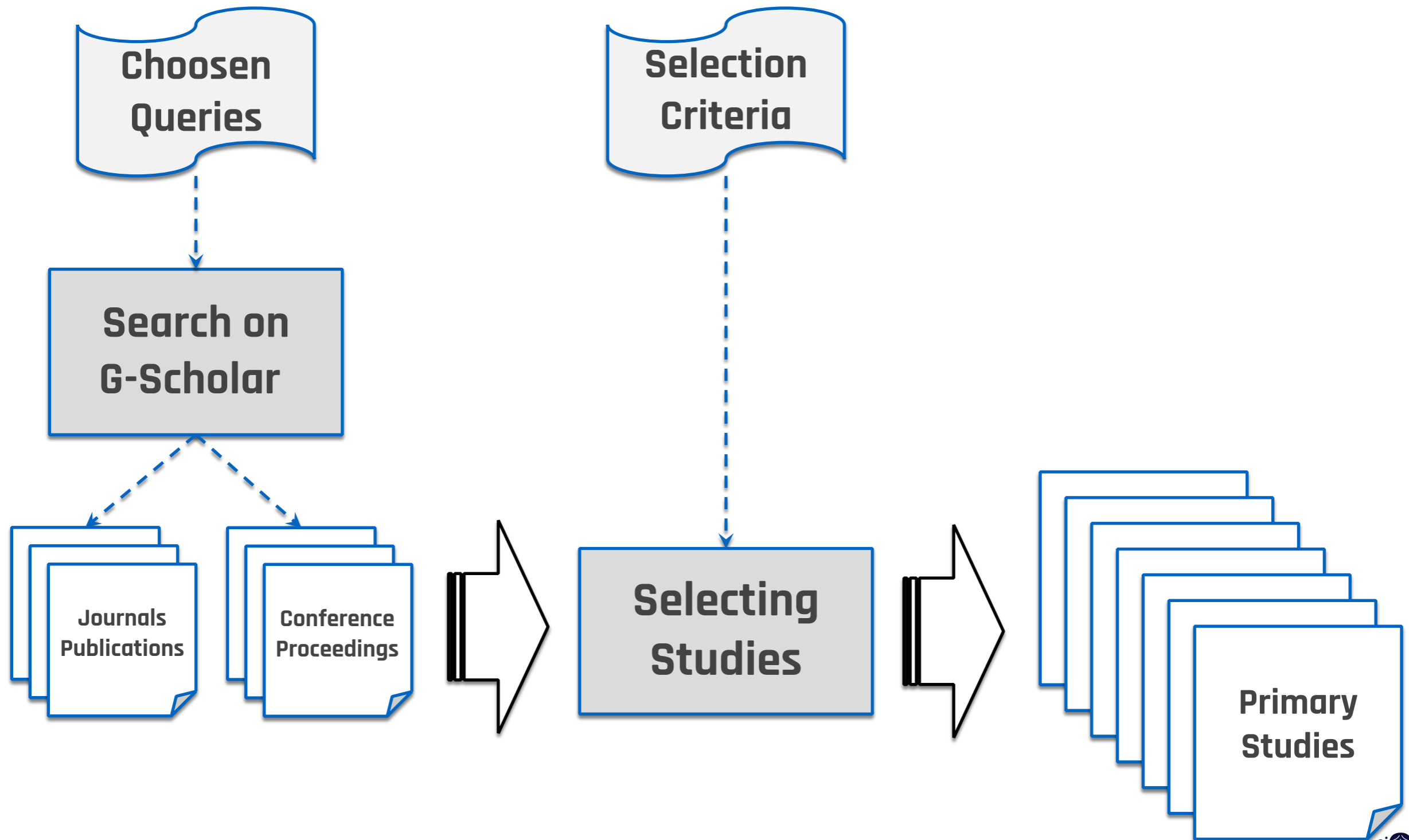
Summary of Literature

By analyzing the literature review, we extracted information on the Year, Country, Academic Area and statistical approach of the reviewed papers.

0 4 9

Reviewed Papers

The dataset of reviewed papers is openly accessible at:

https://github.com/dangeloandrea14/public_SE_fairness

Summary of Literature

Out of the 49 papers we analyzed, only

0 1 6

Papers use Public Data

Other data sources include Surveys, Bibliometric data, and Admission Letters.

Summary of Literature

Out of the 49 papers we analyzed, only

0 0 3

Papers focus on STEM

Most of the papers focused on multiple areas or Medicine.
But can we really group multiple areas?
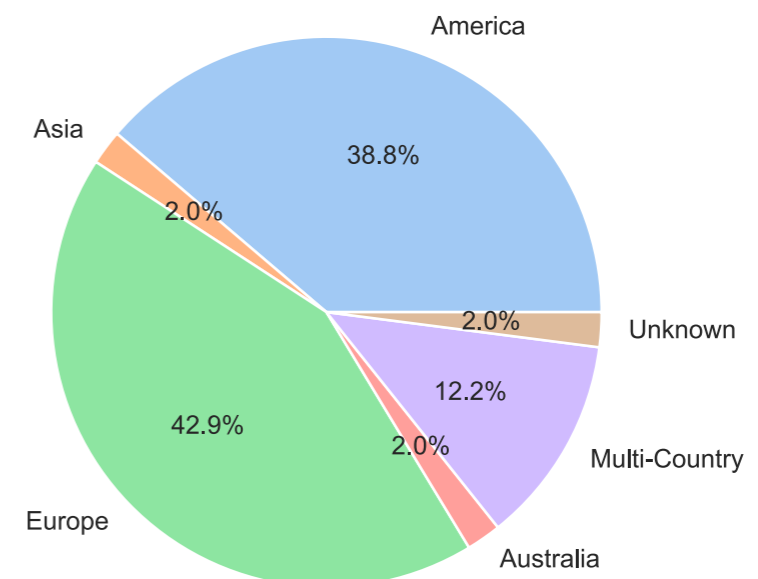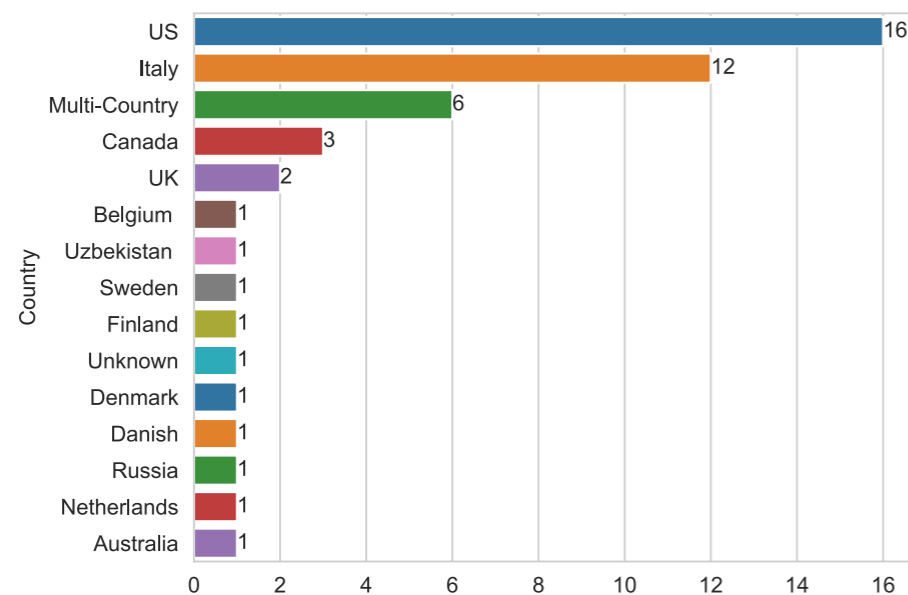
Summary of Literature

Gender bias in Academia has been gaining attention over the last few years.

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pisa-L'Aquila 20-22 november 2023
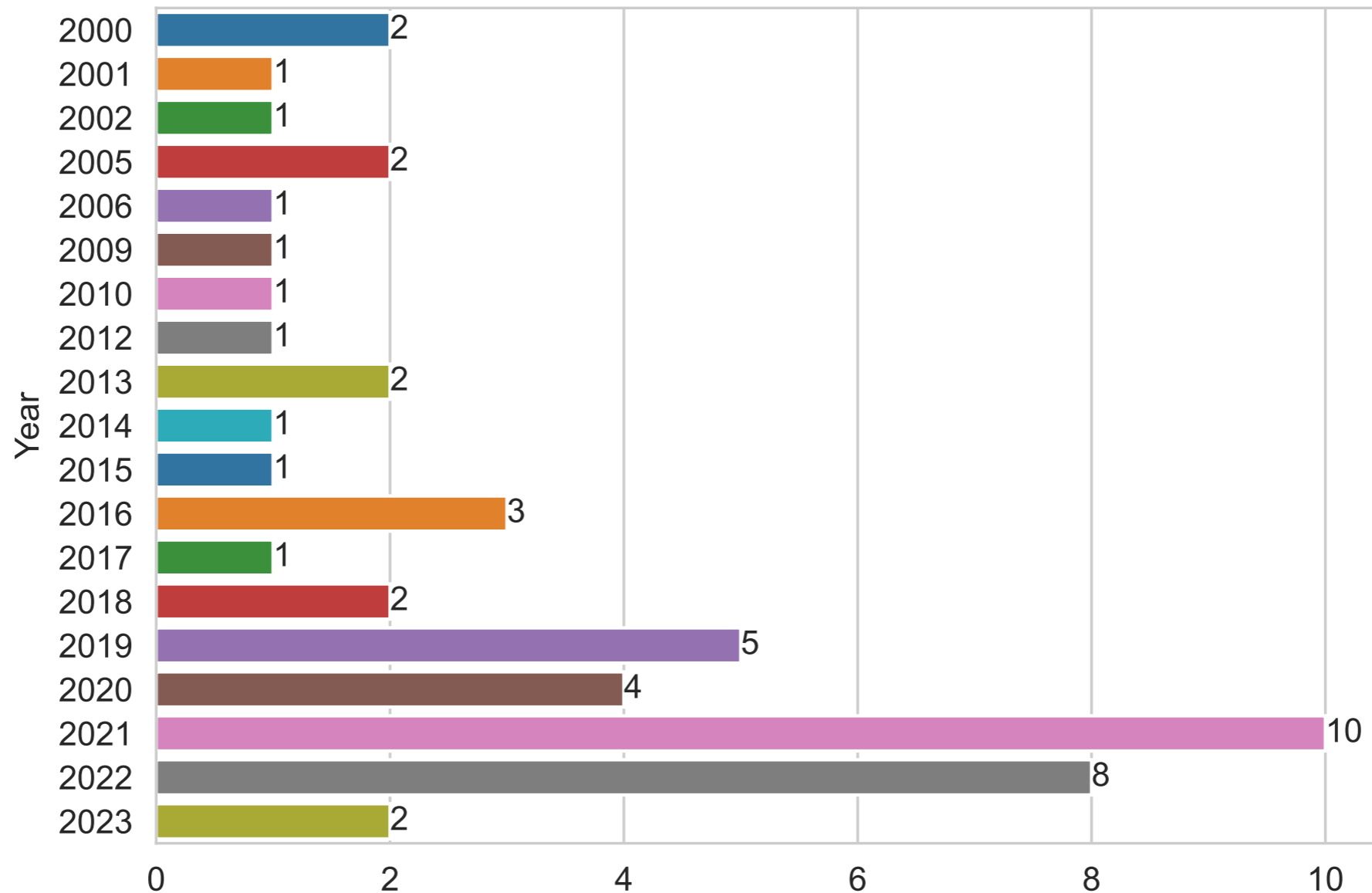
Research Plan

The goal is to study Gender Bias in Academia by employing these steps:

- Publicly available data

- Formal Bias Metric

- Focusing on one group: Software Engineers

- Formal Analysis of Network Behavior

- Public Release of (anonymized) datasets and results

Research Plan (2)

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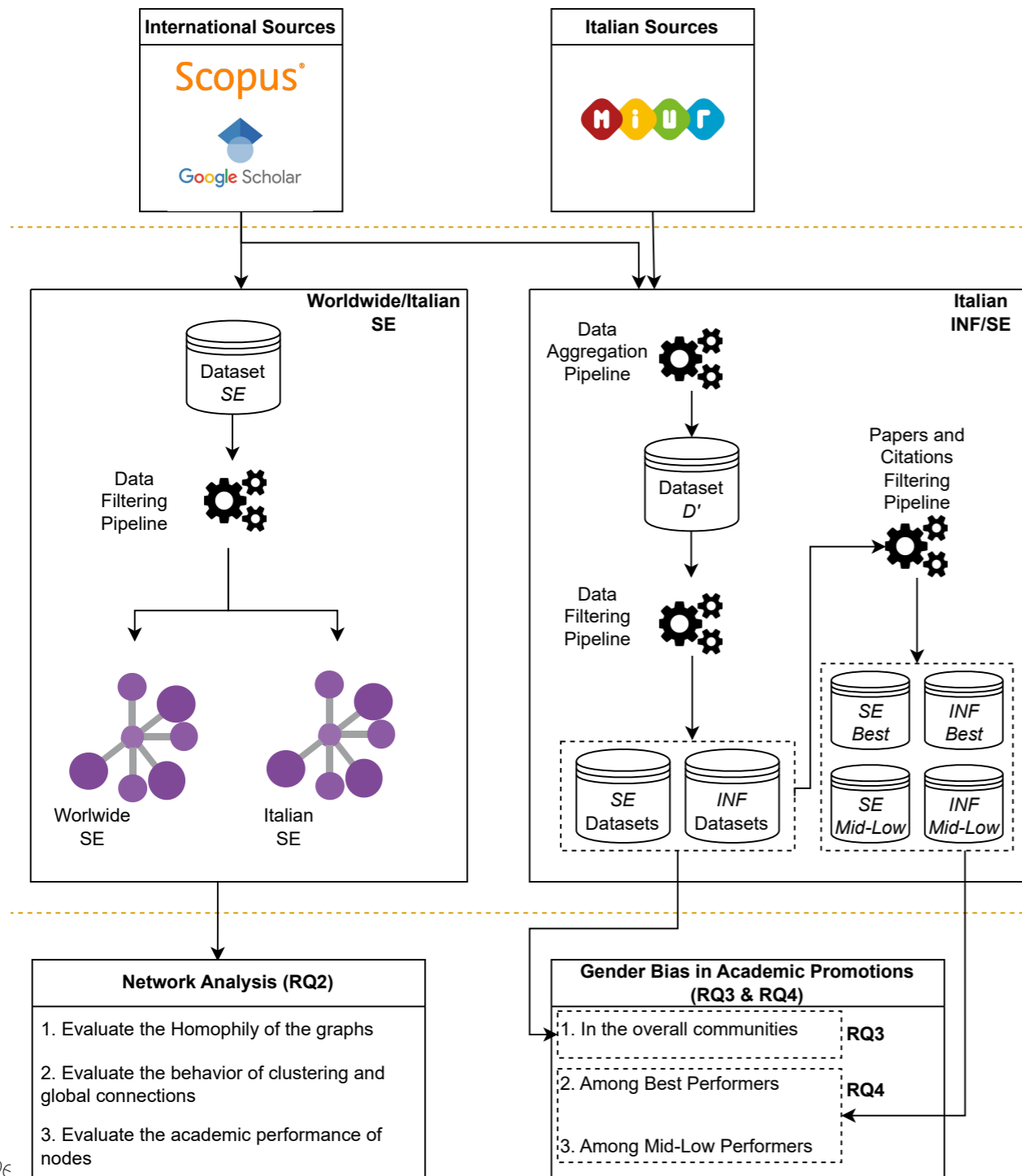
Phase Two

Data Gathering

02

Research Plan

FAIR-EDU: Uncovering Gender Bias in Academia
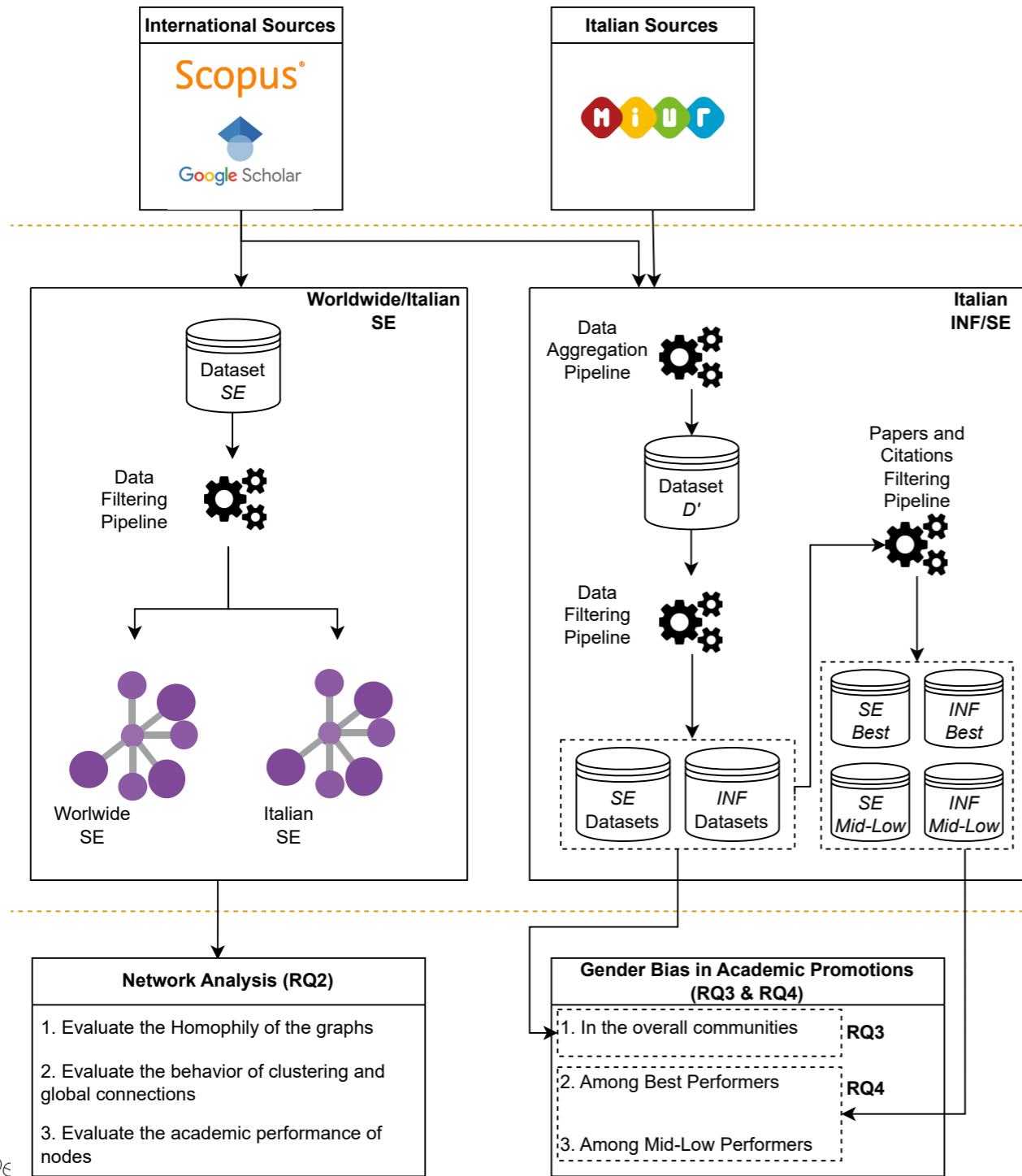
Data Gathering

Data for the academic staff of UAQ and for all Italian public universities were collected and identified.

The information relating to the academic career was downloaded from:

- MIUR public available database:
http://cercauniversita.cineca.it/php5/docenti/cerca.php,
http://ustat.miur.it/

- National Scientific Qualification (ASN archive):
http://abilitazione.miur.it/public/pubblicacandidati.php;

- Scopus API.

Data Gathering

Algorithm for retrieving this information given professor's name, surname, and affiliation:

Algorithm 1 Scopus Search

Input: Name, Surname, AffiliationName.

1: result ← `AuthorSearch`(Name, Surname)
2: **if** size(result) > 0 **then**
3:     **for each** author **in** result **do**
4:         author_info ← `AuthorRetrieval`(author.id)
5:         affiliation_history ← author_info.affiliation_history
6:         **if** affiliation_history **is not** empty **then**
7:             **if** AffiliationName **is in** affiliation_history **then**
8:                 total_papers ← author_info.document_count
9:                 total_citations ← author_info.citation_count
10:                 h_index ← author_info.h_index
11:                 publication_range ← author_info.publication_range
12:                 docs ← author_info.documents
13:                 papers_per_year ← docs.groupby(year).count()
14:                 citations_per_year ← docs.groupby(year, citedby_count).sum()
15:                 paper_types ← docs.groupby(aggregationType).count()
16:                 list_score ← empty list
17:                 **for each** journal **in** docs **do**
18:                     source ← `SerialTitle`(journal.issn or journal.elssn)
19:                     CitScore ← source.citescore
20:                     Sjr ← source.Sjr
21:                     Snip ← source.Snip
22:                     list_score.append(CitScore, Sjr, Snip)
23:                 **end for**
24:             **end if**
25:         **end if**
26:     **end for**
27: **end if**

Output: total_papers, total_citations, h_index, publication_range,
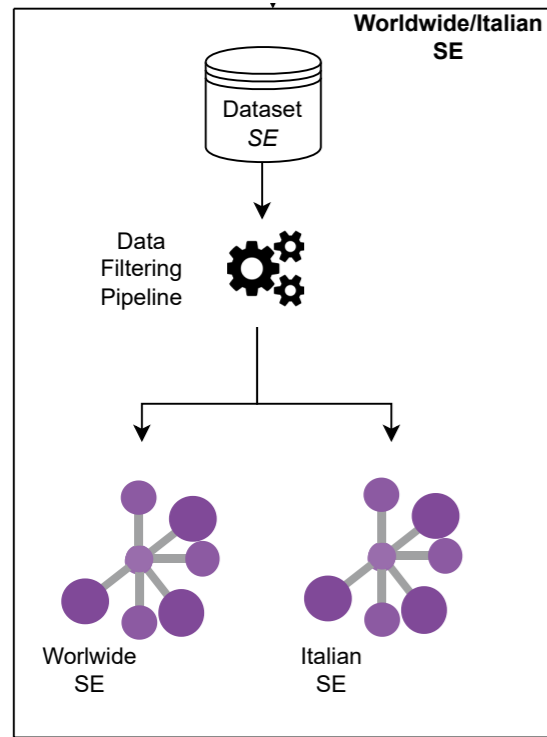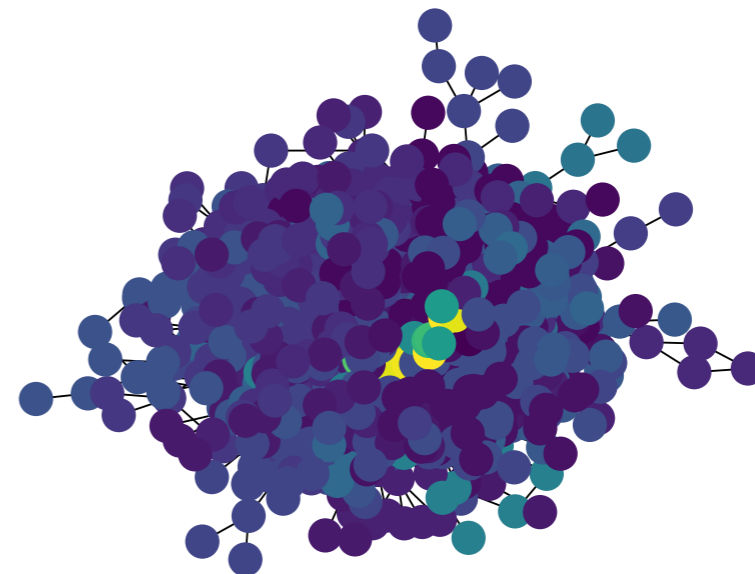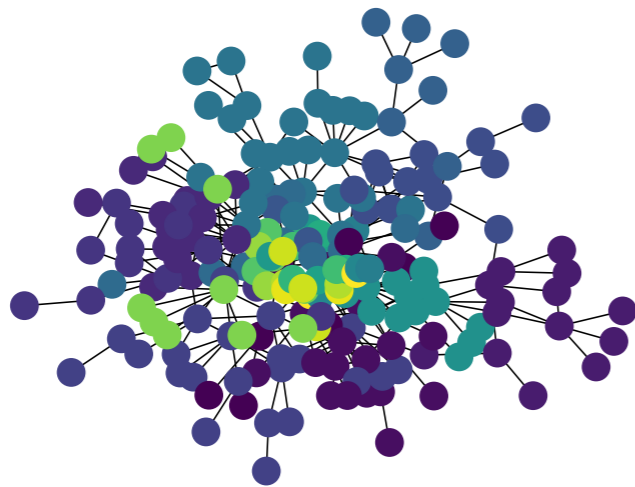**Output:** papers_per_year, citations_per_year, paper_types, list_score
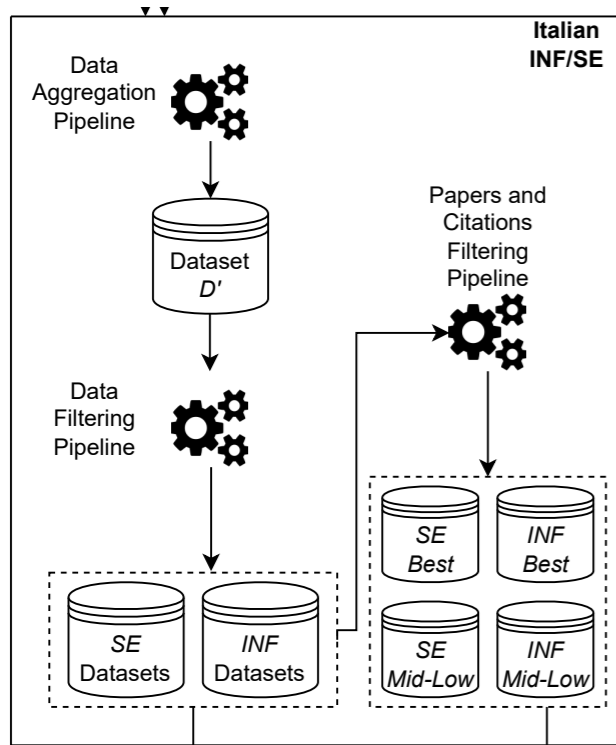

Data Processing
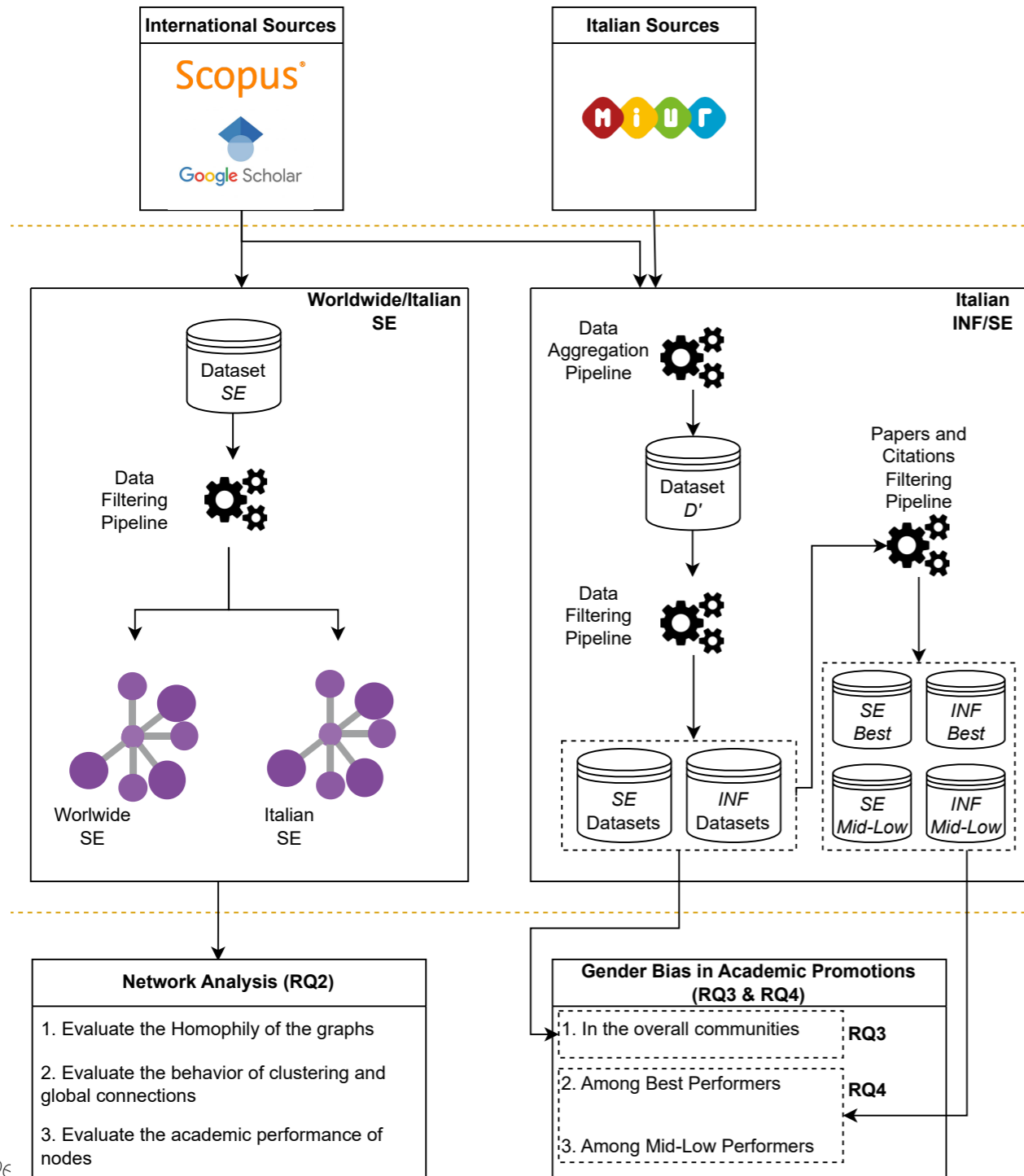
Data Processing

From Scopus:

- We obtain bibliometrics data on all Software Engineers on a global scale;

- We filter the data to obtain Social graphs on their co-authorship relations;

- We build the final graphs.

Data Processing

From Scopus and MIUR:

- We obtain data on the Italian SE community;

- We obtain data on the Informatics SE community;

- We process the datasets in order to be able to compute the formal bias metric.

Disparate Impact (DI):

Disparate Impact compares the probability of having a *Positive Outcome* while being in the *privileged* or *unprivileged* group. Formally:

$$DI = \frac{P(Y = y_p \mid X = x_{unpriv})}{P(Y = y_{p \mid X = x_{priv}})}$$

Phase Three

Evaluation of the BIAS

Measures:
- Network Analysis,
- Disparate Impact

03

Data Processing
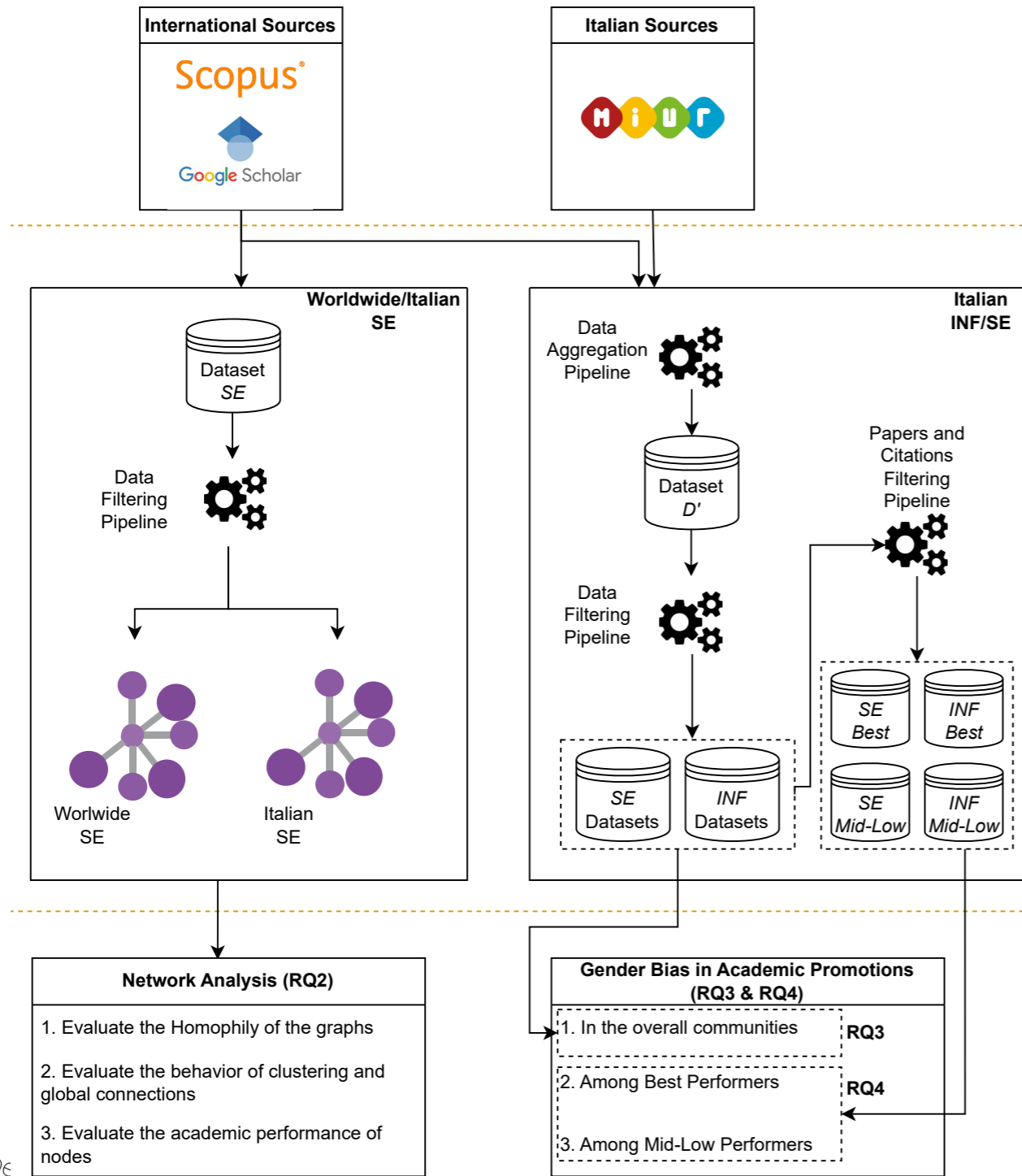
Network Analysis

For the Network Analysis we evaluate:

- **Homophily**; the tendency of researchers to co-author papers with colleagues of the same gender;

- **Clustering Coefficient**; the tendency of researchers to co-author papers with the same group of colleagues every time;

- **Modularity**; the tendency of researchers to look for global connections outside of their working group.

Network Analysis (RQ2)

1. Evaluate the Homophily of the graphs

2. Evaluate the behavior of clustering and global connections

3. Evaluate the academic performance of nodes

Network Analysis

Each node is a researcher

Each edge is a co-authorship relation
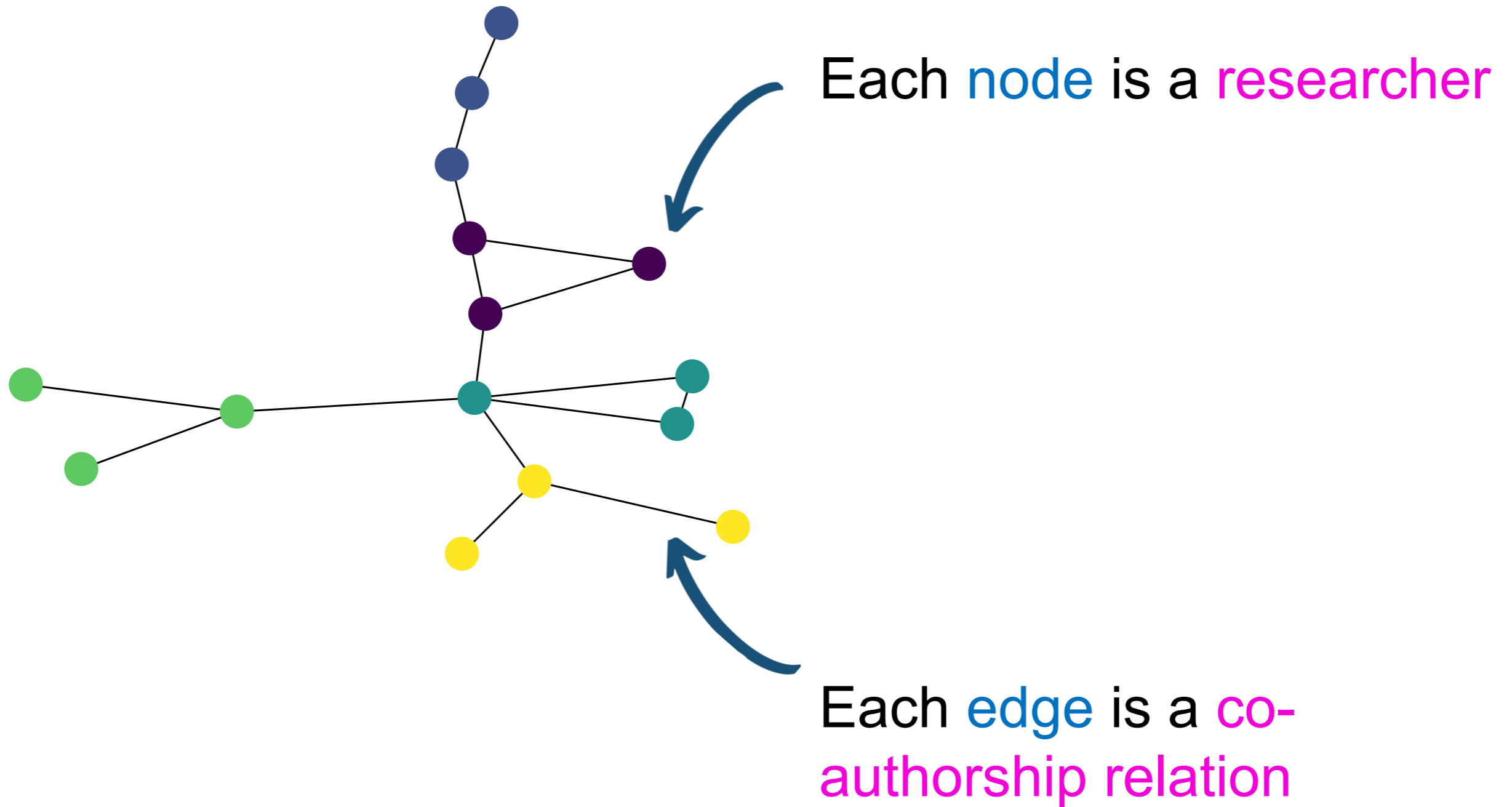
Network Analysis

Homophily: $\dfrac{|e_{cross}|}{|e|}$

Homophily is the tendency of researchers to co-author papers with colleagues of the same gender.

Metric	Europe		Italy	
	Observed	**Ideal**	**Observed**	**Ideal**
Homophily	0.271	0.274	0.41	0.35
Coleman Homophily	0.099	0	-0.011	0

Since the observed values are reasonably close to the ideal values, we infer that gender is not a primary factor in choosing co-authors.

Network Analysis

Clustering Coefficient: $\dfrac{2|T_u|}{\deg(u)\,(\deg(u)-1)}$

Clustering Coefficient is the tendency of researchers to work with tightly-knit groups of people.

Clustering Coefficient in SE community Worldwide
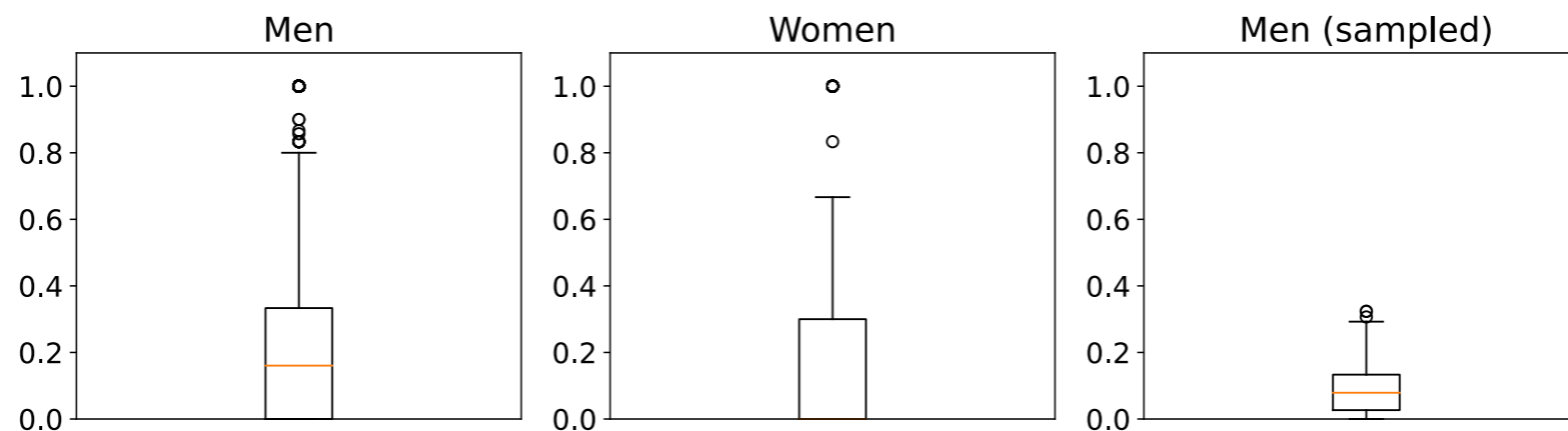
Clustering Coefficient in SE community in Italy
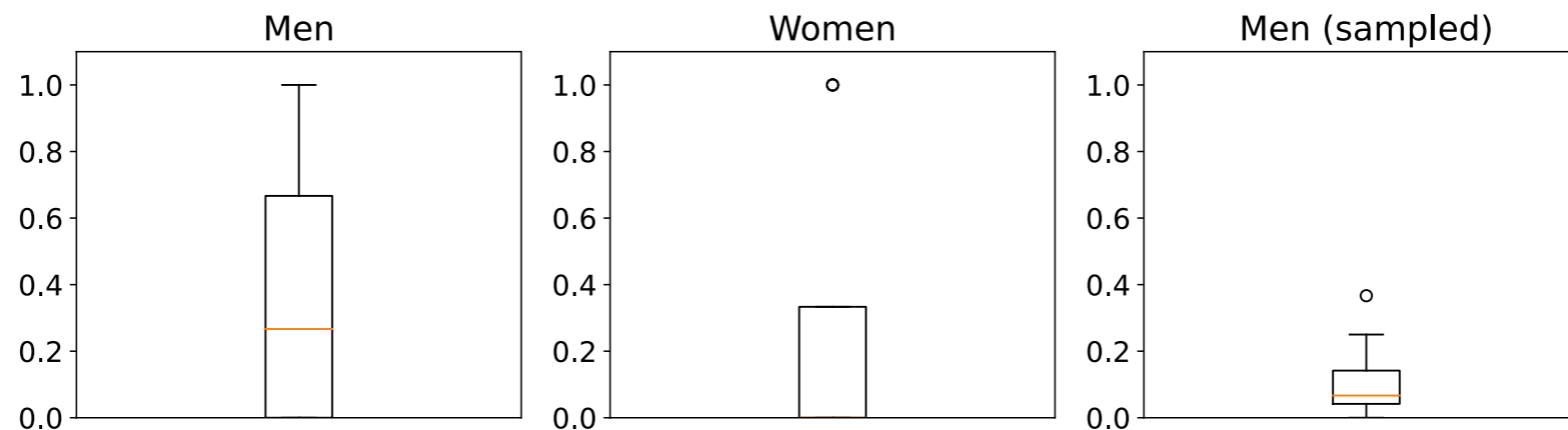
Network Analysis

Modularity: $\frac{1}{2m}\sum_{ij}(A_{ij}\frac{\deg(i)\deg(j)}{2m})\delta(c_i,c_j)$

Modularity is the tendency of researchers to seek global connections.

Italy	Men	0.01
Italy	Women	0.04
Worldwide	Men	0.00035
Worldwide	Women	0.0034

For both the Worldwide and Italian SE communities, Women exhibit much higher Modularity.
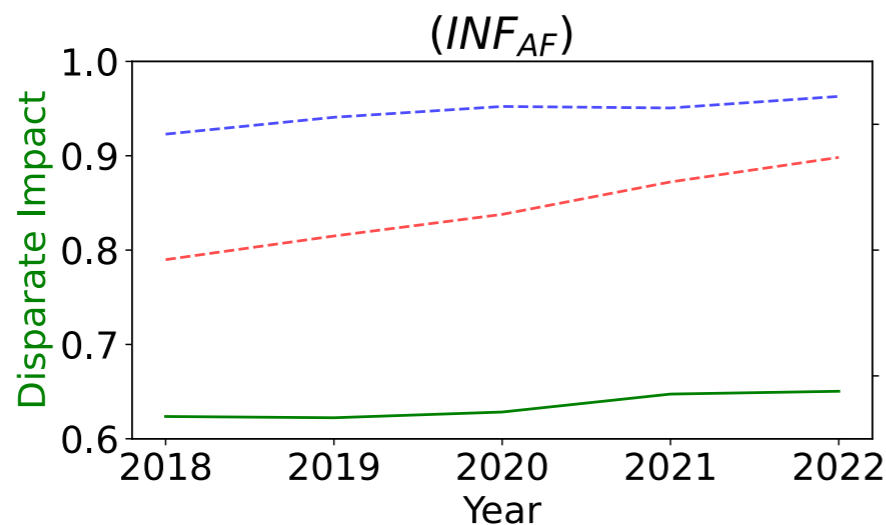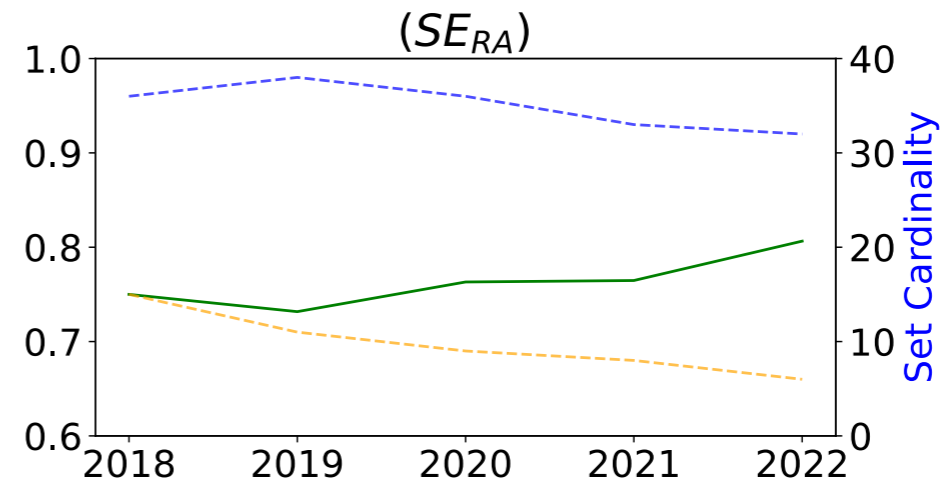
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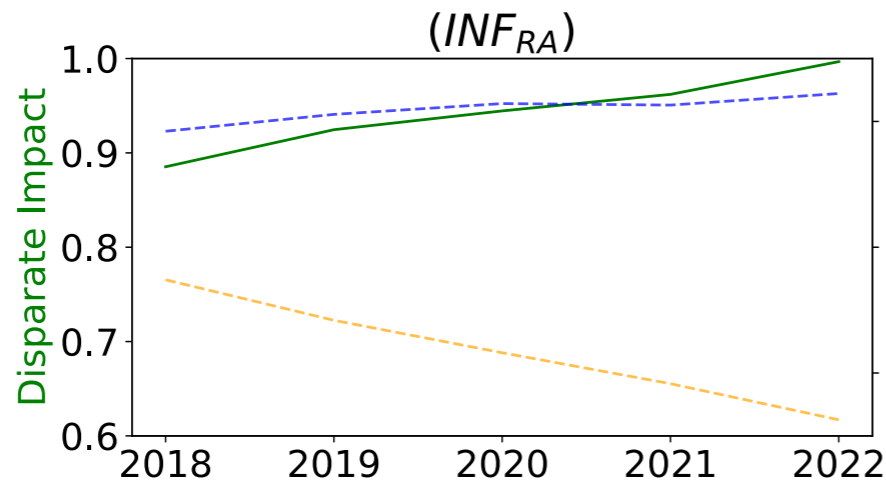
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Bias Analysis

Disparate Impact (DI):

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$$DI = \frac{P(Y = y_p \,|\, X = x_{unpriv})}{P(Y = y_{p \,|\, X = x_{priv}})}$$
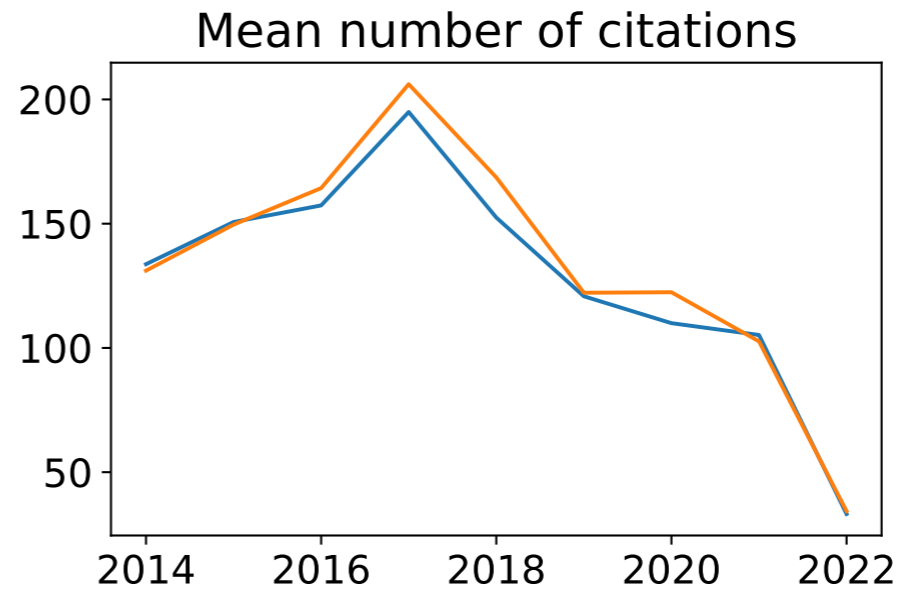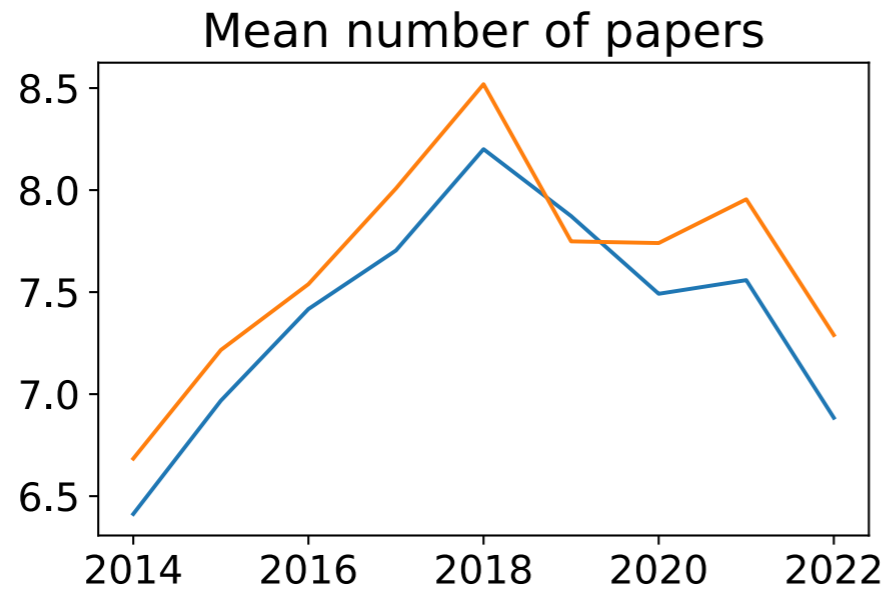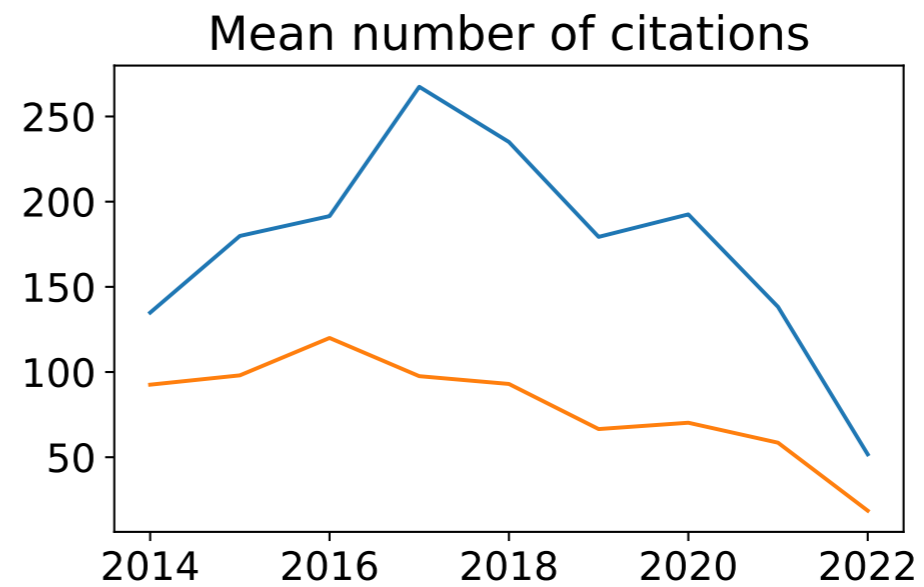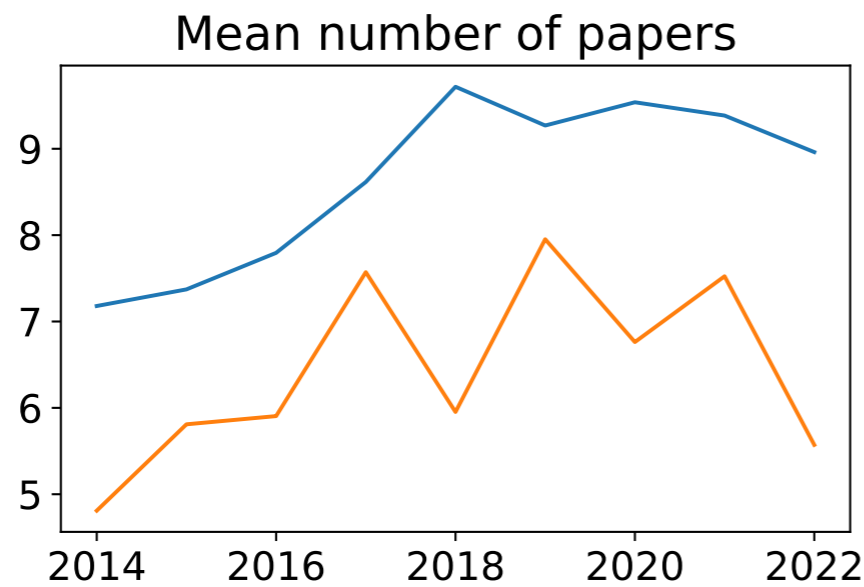
Informatics Community

Software Engineering Community
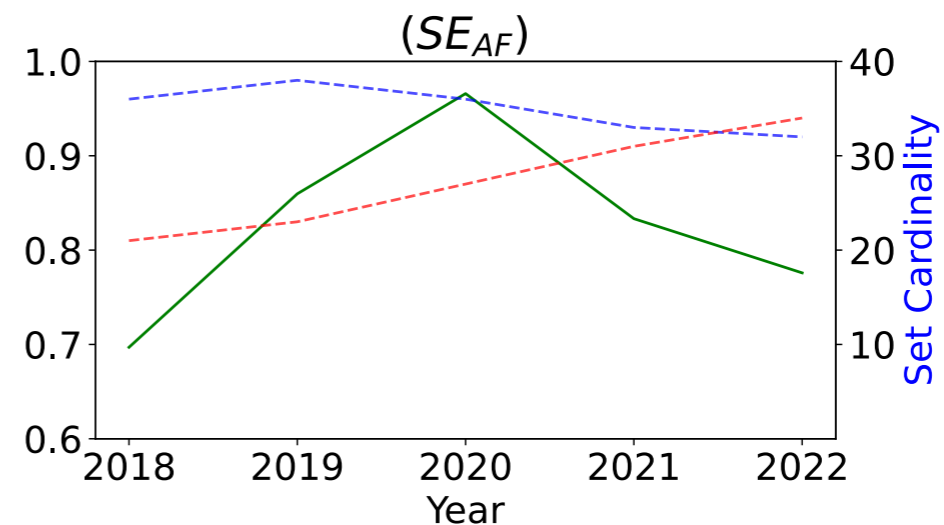
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Academic Performance

Worldwide SE Community

Mean number of papers | Mean number of citations

Italian SE Community

Mean number of papers | Mean number of citations

Men — Women

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Phase Four

Discussion

- Where are the critical points?
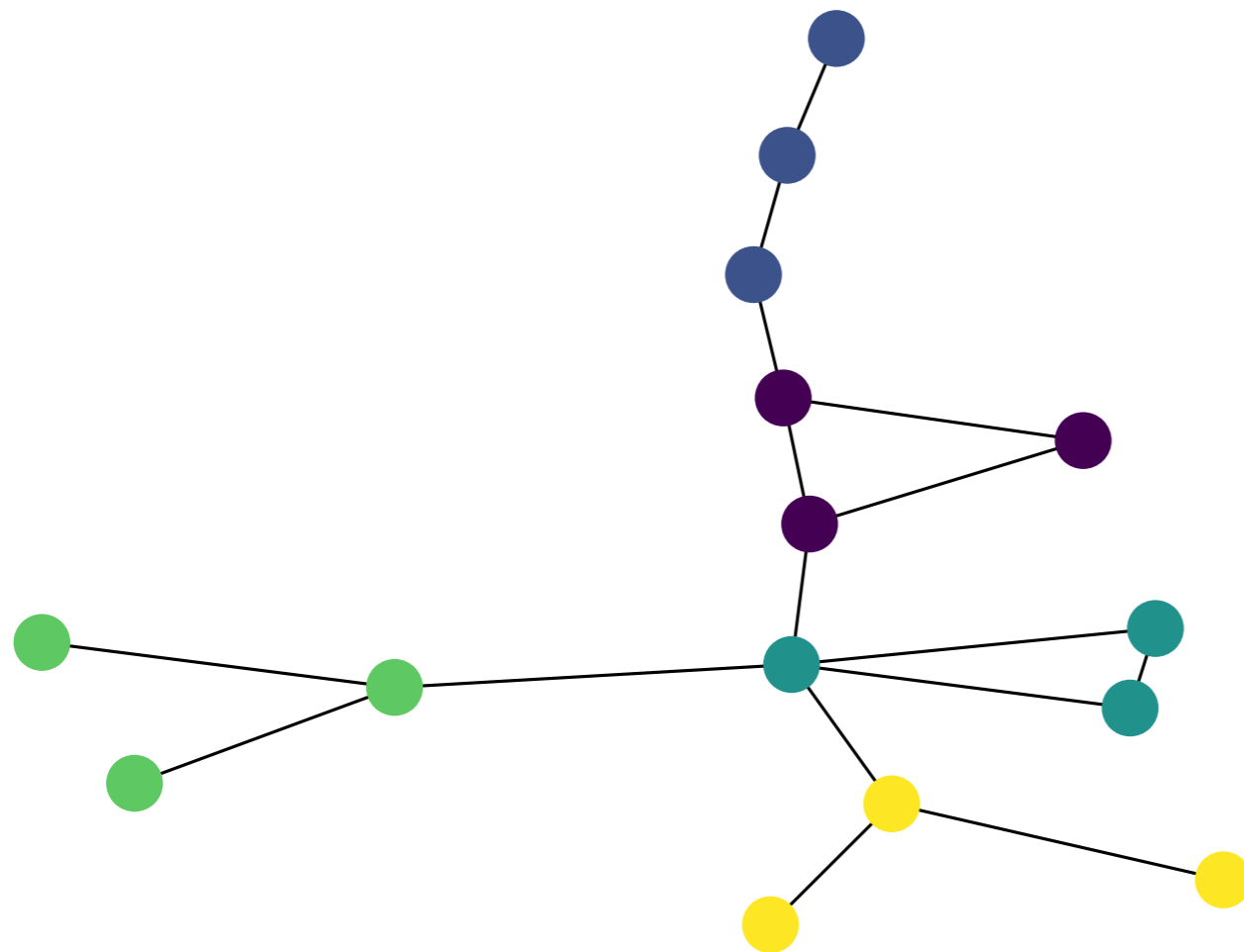
04

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Critical Points

- The number of women in SE is so low that it's hard to compute the degree of Bias.

Social Graph of women in the Italian SE community.

Critical Points

- Most papers in the literature use private data and non-formal definitions of Bias.

Since the topic has been gaining increasing attention in recent years, it is important to standardize the experiments and make the experiments reproducible.

Critical Points

- Men tend to work in more tightly-knit groups, while women seek more global connections.

These conclusions can be inferred by our Network Analysis.
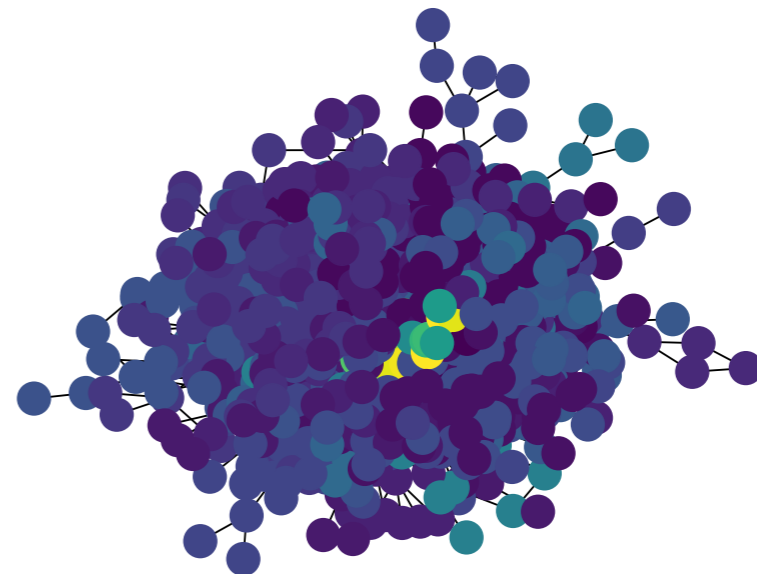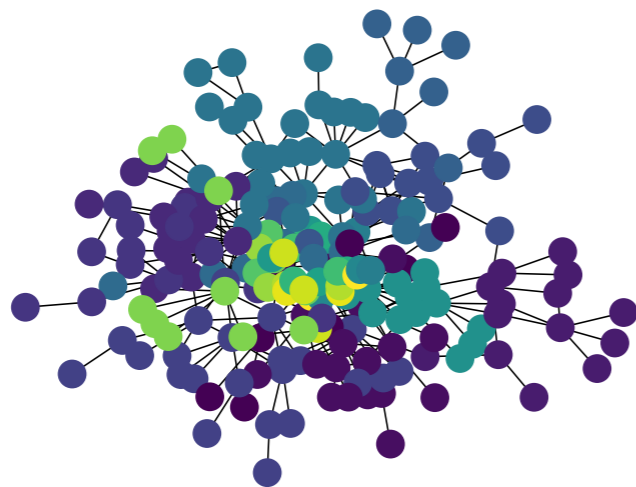
Critical Points

- ## Academic Promotions are biased towards men.

> The Italian SE Community presents a higher gender bias in promotions from Researchers to Associate Professors compared to the overall Informatics Community.

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Early Results

- Early Results were presented in Istanbul at ECSA '23.

Questions?

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