Article Title

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Abstract

The abstract serves both as a general introduction to the topic and as a brief, non-technical summary of the main results and their implications. Authors are advised to check the author instructions for the journal they are submitting to for word limits and if structural elements like subheadings, citations, or equations are permitted.

Keywords: keyword1, Keyword2, Keyword3, Keyword4

1 Introduction

The Introduction section, of referenced text Campbell and Gear (1995) expands on the background of the work (some overlap with the Abstract is acceptable). The introduction should not include subheadings.

Springer Nature does not impose a strict layout as standard however authors are advised to check the individual requirements for the journal they are planning to submit to as there may be journal-level preferences. When preparing your text please also be aware that some stylistic choices are not supported in full text XML (publication version), including coloured font. These will not be replicated in the typeset article if it is accepted.

2 Data and methods

2.1 Data

Data included in this study was retrieved from the Scopus database via the Scopus API using the *pybliomterics* library for Python Rose and Kitchin (2019). We have searched for articles published between 2012 and 2021, and written by authors affiliated with one of the three major Mexican universities, i.e the National Autonomous University of Mexico (UNAM), the National Polytechnic Institute of Mexico (IPN) and the Metropolitan Autonomous University (UAM). The collected data consists of metadata on 74, 400 papers, whose coauthor affiliations are distributed as follows: UNAM 65%, IPN 28%, UAM 2%, coauthors of the remaining 5% of the papers are affiliated with 2 o 3 of the mentioned institutions, see Figure 1. As is shown in figures 1 and 2, the distribution of coauthor affiliations is proportional to the number of associate and professors per institution *Personal académico de la UNAM* (2021); *Personal académico UAM* (2021); *Personal docente del IPN* (2021).
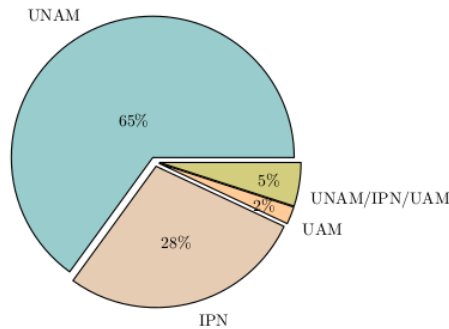

Fig. 1 Distribution of papers among the affiliations of their coauthors

Fig. 2 Number of associated and full professor per institutions

In order to analyze the collaboration networks across different subject areas, we consider the All Science Journal Classification (ASJC) System, which is used in the Scopus database to classify journals and conference proceedings under the following four subject areas: life sciences, physical sciences, health sciences and social sciences. Figure 3 shows the distribution of papers among the different institutions and subject areas. It is important to mention that some papers are classified in more than one subject area, thus the sum of papers per area is greater than the number of papers of all four areas together.
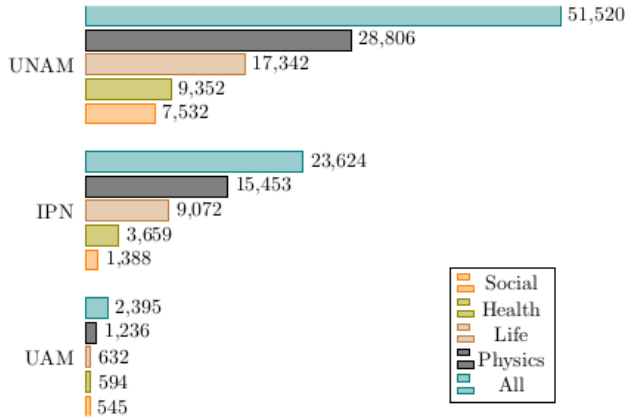
Fig. 3 Distribution of papers among the affiliations of their coauthors and subject areas

2.2 Multilayer co-authorship networks

A multilayer social network is given by a quadruple $M = (A, L, V, E)$, where A is a set of actors (authors for this study), L is a set of layers and (V, E) is a graph such that $V \subseteq A \times L$. Edges in the set E are classified as intralayer and interlayer, where intralayer connects nodes in the same layer and interlayer connects the same nodes in different layers **?**.

We have applied a representation of multilayer co-authorship networks proposed in **?**, where nodes represent authors and the ith layer is formed by authors of articles co-written by i authors. Thus intralayers links represent co-authorship relations and interlayers links connect the same author at different layers. Figure 4 presents an example of four articles mapped in a multilayer co-authorship network.

2.3 Basic metrics

2.3.1 Number of nodes and edges

2.3.2 Density

2.3.3 Number of connected components

2.3.4 Size of the largest connected component

2.3.5 Number of isolated nodes

2.4 Distance metrics

2.4.1 Diameter

Paths and distances

Let i and j be two nodes in a network, a *path* between i and j is a sequence of links that connect them. The number of links in a path is called *path length*.

Then the distance between two nodes i and j, denoted by d_{ij} is equal to the length of the shortest path between them. A popular distance measure in co-authorship networks is the Erdös number of authors, which states the distance between a given author and the great mathematician Paul Erdös.

Finally, the diameter of a network, denoted by d, is the shortest distance between the two most distant nodes. In a co-authorship network, the diameter

2.4.2 Average path legth

2.5 Centrality distributions

2.5.1 Degree centrality

The degree of a node i, denoted bu k_i, is given by the number of nodes that are adjacent to it. In a co-authorship network, the degree of an author indicates the number of its coauthors.

2.5.2 Closeness centrality

The closeness centrality of a node i, denoted by g_i, is given by the inverse sum of distances of node i from all other, i.e.

$$g_i = \frac{1}{\sum_{j \neq i} \ell_{ij}}.$$ (1)

This metric determine how *close* is an author to the rest of authors in a co-authorship network.

2.5.3 Betweenness centrality

Let σ_{hj} be the number of shortest paths between every pair of nodes h and j, except a node i, and let $\sigma_{hj}(i) \subseteq \sigma_{hj}$ be the number of these paths that pass through node i. The betweenness centrality of node i, denoted by b_i, is given by

$$b_i = \sum_{h \neq i \neq j} \frac{\sigma_{hj}(i)}{\sigma_{hj}}.$$ (2)

This metric indicates the fraction of all shortest paths in the networks that pass through a node i. If an author has a high betweenness centrality in a co-authorship network, then it occupies a special position due to it is important for the transmission of information across the network. Thus the betweennesss centrality captures the potential that author has to control the communication between the rest of authors in a co-authorship network.

3 Results

3.1 Discussion and conclusions

3.1.1 This is an example for third level head—subsubsection head

Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text.

4 Equations

Equations in LaTeX can either be inline or on-a-line by itself ("display equations"). For inline equations use the $...$ commands. E.g.: The equation $H\psi = E\psi$ is written via the command `$H \psi = E \psi$`.

For display equations (with auto generated equation numbers) one can use the equation or align environments:

$$\|\tilde{X}(k)\|^2 \leq \frac{\sum_{i=1}^{p} \left\|\tilde{Y}_i(k)\right\|^2 + \sum_{j=1}^{q} \left\|\tilde{Z}_j(k)\right\|^2}{p+q}. \tag{3}$$

where,

$$\begin{aligned} D_\mu &= \partial_\mu - ig\frac{\lambda^a}{2}A_\mu^a \\ F_{\mu\nu}^a &= \partial_\mu A_\nu^a - \partial_\nu A_\mu^a + gf^{abc}A_\mu^b A_\nu^a \end{aligned} \tag{4}$$

Notice the use of \nonumber in the align environment at the end of each line, except the last, so as not to produce equation numbers on lines where no equation numbers are required. The \label{} command should only be used at the last line of an align environment where \nonumber is not used.

$$Y_\infty = \left(\frac{m}{\text{GeV}}\right)^{-3}\left[1 + \frac{3\ln(m/\text{GeV})}{15} + \frac{\ln(c_2/5)}{15}\right] \quad (5)$$

The class file also supports the use of \mathbb{}, \mathscr{} and \mathcal{} commands. As such \mathbb{R}, \mathscr{R} and \mathcal{R} produces $\mathbb{R}$, $\mathscr{R}$ and $\mathcal{R}$ respectively (refer Subsubsection 3.1.1).

5 Tables

Tables can be inserted via the normal table and tabular environment. To put footnotes inside tables you should use \footnotetext[]{...} tag. The footnote appears just below the table itself (refer Tables 1 and 2). For the corresponding footnotemark use \footnotemark[...]

Table 1 Caption text

Column 1	Column 2	Column 3	Column 4
row 1	data 1	data 2	data 3
row 2	data 4	data 5[1]	data 6
row 3	data 7	data 8	data 9[2]

Source: This is an example of table footnote. This is an example of table footnote.

[1]Example for a first table footnote. This is an example of table footnote.

[2]Example for a second table footnote. This is an example of table footnote.

The input format for the above table is as follows:

```
\begin{table}[<placement-specifier>]
\begin{center}
\begin{minipage}{<preferred-table-width>}
\caption{<table-caption>}\label{<table-label>}%
\begin{tabular}{@{}llll@{}}
\toprule
Column 1 & Column 2 & Column 3 & Column 4\\
\midrule
row 1 & data 1 & data 2  & data 3 \\
row 2 & data 4 & data 5\footnotemark[1] & data 6 \\
row 3 & data 7 & data 8  & data 9\footnotemark[2]\\
```

```
\botrule
\end{tabular}
\footnotetext{Source: This is an example of table footnote.
This is an example of table footnote.}
\footnotetext[1]{Example for a first table footnote.
This is an example of table footnote.}
\footnotetext[2]{Example for a second table footnote.
This is an example of table footnote.}
\end{minipage}
\end{center}
\end{table}
```

Table 2 Example of a lengthy table which is set to full textwidth

Project	Element 1[1]			Element 2[2]		
	Energy	σ_{calc}	σ_{expt}	Energy	σ_{calc}	σ_{expt}
Element 3	990 A	1168	1547 ± 12	780 A	1166	1239 ± 100
Element 4	500 A	961	922 ± 10	900 A	1268	1092 ± 40

Note: This is an example of table footnote. This is an example of table footnote this is an example of table footnote this is an example of table footnote this is an example of table footnote.

[1]Example for a first table footnote.

[2]Example for a second table footnote.

In case of double column layout, tables which do not fit in single column width should be set to full text width. For this, you need to use \begin{table*} ... \end{table*} instead of \begin{table} ... \end{table} environment. Lengthy tables which do not fit in textwidth should be set as rotated table. For this, you need to use \begin{sidewaystable} ... \end{sidewaystable} instead of \begin{table*} ... \end{table*} environment. This environment puts tables rotated to single column width. For tables rotated to double column width, use \begin{sidewaystable*} ... \end{sidewaystable*}.

6 Figures

As per the LATEX standards you need to use eps images for LATEX compilation and pdf/jpg/png images for PDFLaTeX compilation. This is one of the major difference between LATEX and PDFLaTeX. Each image should be from a single input .eps/vector image file. Avoid using subfigures. The command for inserting images for LATEX and PDFLaTeX can be generalized. The package used to insert images in LaTeX/PDFLaTeX is the graphicx package. Figures can be inserted via the normal figure environment as shown in the below example:

Table 3 Tables which are too long to fit, should be written using the "sidewaystable" environment as shown here

| Projectile | Element 1[1] | | | Element[2] | | |
	Energy	σ_{calc}	σ_{expt}	Energy	σ_{calc}	σ_{expt}
Element 3	990 A	1168	1547 ± 12	780 A	1166	1239 ± 100
Element 4	500 A	961	922 ± 10	900 A	1268	1092 ± 40
Element 5	990 A	1168	1547 ± 12	780 A	1166	1239 ± 100
Element 6	500 A	961	922 ± 10	900 A	1268	1092 ± 40

Note: This is an example of table footnote this is an example of table footnote this is an example of table footnote this is an example of table footnote this is an example of table footnote this is an example of table footnote.

[1]This is an example of table footnote.

```
\begin{figure}[<placement-specifier>]
\centering
\includegraphics{<eps-file>}
\caption{<figure-caption>}\label{<figure-label>}
\end{figure}
```


Fig. 4 This is a widefig. This is an example of long caption this is an example of long caption this is an example of long caption this is an example of long caption

In case of double column layout, the above format puts figure captions/images to single column width. To get spanned images, we need to provide \begin{figure*} ... \end{figure*}.

For sample purpose, we have included the width of images in the optional argument of \includegraphics tag. Please ignore this.

7 Algorithms, Program codes and Listings

Packages algorithm, algorithmicx and algpseudocode are used for setting algorithms in LATEX using the format:

```
\begin{algorithm}
\caption{<alg-caption>}\label{<alg-label>}
\begin{algorithmic}[1]
. . .
\end{algorithmic}
\end{algorithm}
```

You may refer above listed package documentations for more details before setting algorithm environment. For program codes, the "program" package is required and the command to be used is \begin{program} ... \end{program}. A fast exponentiation procedure:

```
begin
   for i := 1 to 10 step 1 do
      expt(2, i);
      newline() od                    Comments will be set flush to the right margin
where
proc expt(x, n) ≡
   z := 1;
   do if n = 0 then exit fi;
```

do if odd(n) then exit fi;
    comment: This is a comment statement;
    $n := n/2$; $x := x * x$ od;
  $\{n > 0\}$;
  $n := n - 1$; $z := z * x$ od;
print(z).
end

Algorithm 1 Calculate $y = x^n$

Require: $n \geq 0 \vee x \neq 0$
Ensure: $y = x^n$
 1: $y \Leftarrow 1$
 2: **if** $n < 0$ **then**
 3:    $X \Leftarrow 1/x$
 4:    $N \Leftarrow -n$
 5: **else**
 6:    $X \Leftarrow x$
 7:    $N \Leftarrow n$
 8: **end if**
 9: **while** $N \neq 0$ **do**
10:    **if** N is even **then**
11:       $X \Leftarrow X \times X$
12:       $N \Leftarrow N/2$
13:    **else**$[N$ is odd$]$
14:       $y \Leftarrow y \times X$
15:       $N \Leftarrow N - 1$
16:    **end if**
17: **end while**

Similarly, for `listings`, use the `listings` package. `\begin{lstlisting}` ... `\end{lstlisting}` is used to set environments similar to `verbatim` environment. Refer to the `lstlisting` package documentation for more details.

```
for i:=maxint to 0 do
begin
{ do nothing }
end;
Write('Case insensitive ');
Write('Pascal keywords.');
```

8 Cross referencing

Environments such as figure, table, equation and align can have a label declared via the `\label{#label}` command. For figures and table environments use the `\label{}` command inside or just below the `\caption{}` command. You can then use the `\ref{#label}` command to cross-reference them. As an example, consider the label declared for Figure 4 which is `\label{fig1}`. To cross-reference it, use the command `Figure \ref{fig1}`, for which it comes up as "Figure 4".

To reference line numbers in an algorithm, consider the label declared for the line number 2 of Algorithm 1 is `\label{algln2}`. To cross-reference it, use the command `\ref{algln2}` for which it comes up as line 2 of Algorithm 1.

8.1 Details on reference citations

Standard LATEX permits only numerical citations. To support both numerical and author-year citations this template uses `natbib` LATEX package. For style guidance please refer to the template user manual.

Here is an example for `\cite{...}`: Campbell and Gear (1995). Another example for `\citep{...}`: (Slifka & Whitton, 2000). For author-year citation mode, `\cite{...}` prints Jones et al. (1990) and `\citep{...}` prints (Jones et al., 1990).

All cited bib entries are printed at the end of this article: Hamburger (1995), Geddes, Czapor, and Labahn (1992), Broy (1992), Seymour (1981), Smith (1976), Chung and Morris (1978), Hao, AghaKouchak, Nakhjiri, and Farahmand (2014), Babichev, Ries, and Lvovsky (2002), Beneke, Buchalla, and Dunietz (1997) and Stahl (2020).

9 Examples for theorem like environments

For theorem like environments, we require `amsthm` package. There are three types of predefined theorem styles exists—`thmstyleone`, `thmstyletwo` and `thmstylethree`

`thmstyleone`	Numbered, theorem head in bold font and theorem text in italic style
`thmstyletwo`	Numbered, theorem head in roman font and theorem text in italic style
`thmstylethree`	Numbered, theorem head in bold font and theorem text in roman style

For mathematics journals, theorem styles can be included as shown in the following examples:

Theorem 1 (Theorem subhead) *Example theorem text. Example theorem text. Example theorem text. Example theorem text. Example theorem text. Example*

theorem text. Example theorem text. Example theorem text. Example theorem text. Example theorem text. Example theorem text.

Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text.

Proposition 2 *Example proposition text. Example proposition text. Example proposition text. Example proposition text. Example proposition text. Example proposition text. Example proposition text. Example proposition text. Example proposition text. Example proposition text.*

Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text.

Example 1 Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem.

Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text.

Remark 1 Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem.

Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text.

Definition 1 (Definition sub head) Example definition text. Example definition text. Example definition text. Example definition text. Example definition text. Example definition text. Example definition text. Example definition text.

Additionally a predefined "proof" environment is available: `\begin{proof} ... \end{proof}`. This prints a "Proof" head in italic font style and the "body text" in roman font style with an open square at the end of each proof environment.

Proof Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. □

Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text. Sample body text.

Proof of Theorem 1 Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. Example for proof text. □

For a quote environment, use `\begin{quote}...\end{quote}`

> Quoted text example. Aliquam porttitor quam a lacus. Praesent vel arcu ut tortor cursus volutpat. In vitae pede quis diam bibendum placerat. Fusce elementum convallis neque. Sed dolor orci, scelerisque ac, dapibus nec, ultricies ut, mi. Duis nec dui quis leo sagittis commodo.

Sample body text. Sample body text. Sample body text. Sample body text. Sample body text (refer Figure 4). Sample body text. Sample body text. Sample body text (refer Table 3).

10 Methods

Topical subheadings are allowed. Authors must ensure that their Methods section includes adequate experimental and characterization data necessary for others in the field to reproduce their work. Authors are encouraged to include RIIDs where appropriate.

Ethical approval declarations (only required where applicable) Any article reporting experiment/s carried out on (i) live vertebrate (or higher invertebrates), (ii) humans or (iii) human samples must include an unambiguous statement within the methods section that meets the following requirements:

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11 Discussion

Discussions should be brief and focused. In some disciplines use of Discussion or 'Conclusion' is interchangeable. It is not mandatory to use both. Some journals prefer a section 'Results and Discussion' followed by a section 'Conclusion'. Please refer to Journal-level guidance for any specific requirements.

12 Conclusion

Conclusions may be used to restate your hypothesis or research question, restate your major findings, explain the relevance and the added value of your work, highlight any limitations of your study, describe future directions for research and recommendations.

In some disciplines use of Discussion or 'Conclusion' is interchangeable. It is not mandatory to use both. Please refer to Journal-level guidance for any specific requirements.

Supplementary information. If your article has accompanying supplementary file/s please state so here.

Authors reporting data from electrophoretic gels and blots should supply the full unprocessed scans for key as part of their Supplementary information. This may be requested by the editorial team/s if it is missing.

Please refer to Journal-level guidance for any specific requirements.

Acknowledgments.   Acknowledgments are not compulsory. Where included they should be brief. Grant or contribution numbers may be acknowledged.

Please refer to Journal-level guidance for any specific requirements.

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Some journals require declarations to be submitted in a standardised format. Please check the Instructions for Authors of the journal to which you are submitting to see if you need to complete this section. If yes, your manuscript must contain the following sections under the heading 'Declarations':

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- Consent to participate
- Consent for publication
- Availability of data and materials
- Code availability
- Authors' contributions

If any of the sections are not relevant to your manuscript, please include the heading and write 'Not applicable' for that section.

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Appendix A   Section title of first appendix

An appendix contains supplementary information that is not an essential part of the text itself but which may be helpful in providing a more comprehensive understanding of the research problem or it is information that is too cumbersome to be included in the body of the paper.

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