ArXiv Classifier [Title Name?]

[Subtitle / Tagline]

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*Abstract*—This study investigates the effectiveness of various neural network architectures for automatically classifying scientific papers from arXiv into their respective research domains. We evaluate eight models ranging from simple logistic regression to complex BERT-based networks on a dataset of over 100,000 papers across eight major research categories. Our experiments demonstrate that moderate complexity architectures, particularly shallow neural networks, achieve the best balance of accuracy (72%) and computational efficiency. More sophisticated models like BERT and RNNs showed poor generalisation despite higher computational costs. The results provide practical insights for implementing automated paper classification systems while highlighting significant trade-offs between model complexity and performance. We identify critical challenges around class imbalance and training stability and propose directions for future improvements. This work contributes to the growing body of research on automated document classification while offering concrete recommendations for practical implementations in academic and research contexts.

# Introduction

This report comprehensively analyses machine learning approaches for automatically classifying scientific papers from arXiv into their respective research domains. The study evaluates eight neural network architectures, ranging from simple logistic regression to complex BERT-based models, to determine the most effective approach for this multi-class text classification task.

The key objectives of this research are:

1. Evaluate different neural network architectures for scientific paper classification.
2. Compare model performance across varying levels of complexity.
3. Identify the most effective architecture for practical implementation.
4. Analyse the trade-offs between model sophistication and performance.

Our experiments demonstrate that moderate-complexity models, particularly shallow neural networks, achieve the best balance between accuracy and computational efficiency. The findings provide practical insights for implementing automated paper classification systems while highlighting important considerations around model selection and training.

The report is structured as follows:

1. Data collection and preprocessing methodology
2. Feature engineering approaches
3. Detailed analysis of eight model architectures
4. Comparative evaluation of model performance
5. Discussion of key findings and trade-offs
6. Recommendations for practical implementation
7. Future research directions

This work contributes to the growing body of research on automated document classification while providing practical guidance for implementing similar systems in academic and research contexts.

# Data Scraping

The data scraping process involved collecting metadata from the arXiv repository, focusing on eight primary research categories. 863,251 paper details were initially scraped and stored in a file named `arxiv\_large.csv`. Due to the large size of this dataset, two smaller subsets were created for different purposes:

1. `arxiv\_lite.csv`: A sample of 2,000 papers used for code experimentation and initial testing.
2. `arxiv.csv`: A more extensive sample of 107,944 papers used for the actual implementation and model training.

The data scraping was done using a Python script (`data\_scraping.py`), including the following key components.

## Data Collection

The data collection process used the `arxiv` Python package to interface with the arXiv API. We focused on scraping papers from the following eight primary research categories:

1. Physics
2. Mathematics
3. Computer Science
4. Quantitative Biology
5. Quantitative Finance
6. Statistics
7. Electrical Engineering and Systems Science
8. Economics

Each category was carefully selected to ensure a diverse and representative sample of scientific research papers.

## Data Processing

The metadata for each paper was meticulously extracted, including the following fields:

1. Title
2. Summary/Abstract
3. Authors
4. Category
5. Comments
6. Publication Date

Subsequently, the text data underwent a thorough cleaning process:

1. Resolved encoding issues by standardising to UTF-8 and Windows-1252 encodings.
2. Eliminated line breaks within summaries to ensure consistency.
3. Consolidated author names into a single string, separated by commas.

To facilitate analysis, categories were systematically mapped to their broader parent categories (e.g., cs.AI was mapped to computer science).

## Dataset Creation

The dataset creation process involved several critical steps to ensure the quality and usability of the data for machine learning tasks:

1. Deduplication: Papers were deduplicated based on their unique arXiv ID to remove redundant entries.
2. Data Splitting: The dataset was divided into three subsets:
   1. Training Set: 63% of the data, used to train the models.
   2. Validation Set: 27% of the data, used to tune model parameters and prevent overfitting.
   3. Test Set: 10% of the data, used to evaluate the final model performance.
3. Stratification: The splits were stratified by category to ensure that the class distribution was maintained across all subsets.
4. Saving Datasets: The final datasets were saved in CSV format for easy access and further processing:

- `arxiv\_lite.csv`: Contains 2,000 papers, used for initial testing and code experimentation.

- `arxiv.csv`: Contains 107,944 papers, used for the main implementation and model training.

- `arxiv\_large.csv`: Contains 863,251 papers, representing the full dataset.

These steps ensured that the datasets were well-prepared for subsequent analysis and model development.

Lorem ipsum.

# Ease of Use

## Selecting a Template (Heading 2)

First, confirm that you have the correct template for your paper size. This template has been tailored for output on the A4 paper size. If you are using US letter-sized paper, please close this file and download the Microsoft Word, Letter file.

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Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

## Units

* Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as “3.5-inch disk drive”.
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Identify applicable funding agency here. If none, delete this text box.

* Use a zero before decimal points: “0.25”, not “.25”. Use “cm3”, not “cc”. (*bullet list*)

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The equations are an exception to the prescribed specifications of this template. You will need to determine whether or not your equation should be typed using either the Times New Roman or the Symbol font (please no other font). To create multileveled equations, it may be necessary to treat the equation as a graphic and insert it into the text after your paper is styled.

Number equations consecutively. Equation numbers, within parentheses, are to position flush right, as in (1), using a right tab stop. To make your equations more compact, you may use the solidus ( / ), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

*a**b* 

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## Some Common Mistakes

* The word “data” is plural, not singular.
* The subscript for the permeability of vacuum **0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.
* In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
* A graph within a graph is an “inset”, not an “insert”. The word alternatively is preferred to the word “alternately” (unless you really mean something that alternates).
* Do not use the word “essentially” to mean “approximately” or “effectively”.
* In your paper title, if the words “that uses” can accurately replace the word “using”, capitalize the “u”; if not, keep using lower-cased.
* Be aware of the different meanings of the homophones “affect” and “effect”, “complement” and “compliment”, “discreet” and “discrete”, “principal” and “principle”.
* Do not confuse “imply” and “infer”.
* The prefix “non” is not a word; it should be joined to the word it modifies, usually without a hyphen.
* There is no period after the “et” in the Latin abbreviation “et al.”.
* The abbreviation “i.e.” means “that is”, and the abbreviation “e.g.” means “for example”.

An excellent style manual for science writers is [7].

# Using the Template

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

## Authors and Affiliations

**The template is designed for, but not limited to, six authors.** A minimum of one author is required for all conference articles. Author names should be listed starting from left to right and then moving down to the next line. This is the author sequence that will be used in future citations and by indexing services. Names should not be listed in columns nor group by affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization).

### For papers with more than six authors: Add author names horizontally, moving to a third row if needed for more than 8 authors.

### For papers with less than six authors: To change the default, adjust the template as follows.

#### Selection: Highlight all author and affiliation lines.

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## Identify the Headings

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is “Heading 5”. Use “figure caption” for your Figure captions, and “table head” for your table title. Run-in heads, such as “Abstract”, will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced. Styles named “Heading 1”, “Heading 2”, “Heading 3”, and “Heading 4” are prescribed.

## Figures and Tables

#### Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation “Fig. 1”, even at the beginning of a sentence.

1. Table Type Styles

| Table Head | Table Column Head | | |
| --- | --- | --- | --- |
| Table column subhead | Subhead | Subhead |
| copy | More table copya |  |  |

1. Sample of a Table footnote. (*Table footnote*)
2. Example of a figure caption. (*figure caption*)

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

##### Acknowledgment *(Heading 5)*

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

##### References

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Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

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For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

1. G. Eason, B. Noble, and I. N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. *(references)*
2. J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
3. I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
4. K. Elissa, “Title of paper if known,” unpublished.
5. R. Nicole, “Title of paper with only first word capitalized,” J. Name Stand. Abbrev., in press.
6. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
7. M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.

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