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# An Anticipatory Algorithm for the Reviewer Assignment Issue using Machine learning Methods

**Bhanu Prakash Dubey**
Asst. Professor, Department of CSE (Computer Sc), GEHU-Dehradun Campus

**Abstract**: Reviewer assignment is the process of matching submitted articles with qualified reviewers for objective feedback. Reviewer Assignment Problem (RAP) refers to the challenge of finding qualified reviewers and matching them with publications that meet minimal requirements. The goal of this study is to gain a better understanding of the RAP domain by investigating the current state of research, the breadth and depth of existing approaches, the potential for future development, the difficulties inherent in the field, and the potential for novel solutions to the reviewer assignment problem. According to the results, researchers in the RAP area are mostly interested in finding ways to increase automation, fairness, accuracy, and subject coverage. The primary objective of the proposed study is to create a proactive mechanism for assigning reviewers to papers using machine learning methods. The study suggests two systems that are built utilising machine learning techniques. Unsupervised learning based Proactive Reviewer Paper Assignment System (UPRPAS) and deep learning based Proactive Reviewer Paper Assignment System (DPRPAS) are the names of the two systems presented. UPRPAS is an unsupervised method that uses Latent Dirichlet Allocation to construct a reviewer and article topic model..

**Keywords:** Reviewer Assignment Problem, Unsupervised learning based Proactive Reviewer Paper Assignment System, Deep learning based Proactive Reviewer Paper Assignment System, Latent Dirichilet Allocation

## Introduction

There has been a dramatic increase in the number of submissions to conferences and publications across all disciplines. Many thousands of articles are submitted to conferences and publications annually, and reviewers must be selected from a pool of several hundred to several thousand professionals. The process of manually allocating papers to reviewers at such conferences has become untenable. The graph depicts annual publishing counts for various types of publications. They are categorised by both publication year and genre. Papers presented at conferences, articles in scholarly journals, books, theses, informal writings, book chapters, and encyclopaedias all count as publications. Even at Nature, editors have found it difficult to locate enough reviewers in recent years, ostensibly due to an increase in submissions. The total number of published papers in PubMed almost doubled between 2010 and 2015.

Publication itself involves peer evaluation, a crucial step in the research and development process. The credibility of academic journals and conferences depends on the quality of their published works. As a result, maintaining quality necessitates that each article be reviewed consistently and properly by a group of experts. When it comes to the peer review process as a whole, one of the most important and difficult responsibilities is assigning reviewers to publications. Reviewer Assignment Problem (RAP) refers to the process of finding qualified reviewers and assigning them to publications that meet certain criteria. Manual assignment is now too time-consuming and laborious to be handled by a single programme chair or small group of committee members. In addition, within a certain time frame, the publication must be assigned to reviewers who are well-versed in both the research presented in the paper and the relevant fields of study. Many elite conferences have a low acceptance rate because they go to great lengths to ensure that each paper is reviewed by the most knowledgeable specialists in the field. The practise of soliciting bids from specialists to examine submitted publications is commonplace in several big scientific groups, such as the Association for the Advancement of Artificial Intelligence (AAAI) [16]. After collecting expert bids, the programme chair distributes each paper to a small group of highly qualified reviewers using sophisticated matching algorithms. The topic areas of the papers and the knowledge domain of the reviewers are two crucial elements involved in the accurate and fair assignment, as shown by a study of 10 such bid methodologies provided by researchers utilising data from the Joint Conference on Digital Libraries (JCDL) from 2005. As a corollary, this means that in order to achieve the conference's objective of fair and accurate assignment and review, the process must account for experts' load constraints, sufficient numbers of reviews for each paper, the absence of conflicts of interest, expertise pro le

modelling, and the overall equal distribution of paper assignments taking the preferences registered into account.

The purpose of peer review is to ensure the credibility of academic publications and to foster collaboration among experts in the field. Researchers have shown that even a moderate variance in reviewer opinion may significantly affect the reliability of a publication. Most journal editors and conference chairmen utilise the rule of thumb "to seek reviews by multiple reviewers covering most of the paper domains," which has been acknowledged favourably by further research.

Our primary goal is to find a way to fix the issue of assigning reviewers to papers. The purpose of this study is to provide a more precise and efficient method of assigning reviewers to papers for peer review. Cascade-building profiles, similarity calculation, and assignment are the three fundamental pillars on which the reliability of article assignment to reviewers rests. In the same way that mistakes in one stage might affect the next, doing well in one stage will almost certainly help the accuracy of the whole system. With this in mind, the suggested system's development and deployment use a preventative, proactive approach. An effort is made to foresee potential sources of inaccuracy and implement countermeasures before they occur by pinpointing accuracy-enhancing characteristics. The primary focus is on making appropriate reviewer assignments for submitted publications.

Appointing reviewers is an essential part of many research processes, including planning conferences and assessing funding submissions. However, it's a lengthy and complicated procedure for conference organisers and journal editors to manually assign submitted articles to eligible reviewers. Journal editors and conference organisers often ask for reviewers to sign up and indicate their preferred research fields and presentation topics. Journal editors and conference chairmen use this information to pair articles with reviewers. It is necessary to update the system often to account for any changes in reviewers' areas of interest. Manually assigning manuscripts to the relevant reviewers using keywords may be difficult because even if reviewer profiles are kept up-to-date, reviewers may not be acquainted with all research directions. Bidding is a method used by several conference management systems. Reviewers need to read every single submitted paper, but they often don't have the time to do so in order to appropriately bid based on their knowledge, interests, and preferences [2]. They don't have to read the whole paper, only the abstracts and titles, which may help them make a more informed decision. Systems designed for this purpose are sometimes referred to as "recommendation systems for reviewer assignments" in the relevant literature. Today's researchers and students may benefit greatly from recommendation systems tailored to the task of reviewing technical papers. Assigning papers to reviewers without considering their expertise and interests can increase the likelihood that papers will be rejected, which in turn can cause author dissatisfaction and delay the conference's progress. A more effective system is needed, one that takes into account academic social networks, expertise with sub-categories, dynamic information, and the identification of expertise domains, as well as the preferences of reviewers and the number of publications and citations/h-index/i-index of experts.

**Unsupervised Proactive Reviewer Paper Assignment System**

This paper provides the Proactive Reviewer Paper Assignment System's design, algorithms, and the specific operation of each functional block. Both a Deep Learning based Proactive Reviewer Paper Assignment System (DPRPAS) and an Unsupervised Proactive Reviewer Paper Assignment System (UPRPAS) may be used to describe this body of work. Latent Dirichlet Allocation is used for topic modelling in the proposed UPRPAS. This chapter details the techniques used by UPRAPS to create paper profiles, reviewer profiles, compute similarity, rank papers, and assign reviewers to papers. By mining the titles, abstracts, and abstract summaries of manuscripts, the proposed DPRAPS creates phrase pairings. These word combinations are used as expert knowledge by supervisors to the task of assigning reviewers. The article describes UPRAPS's system architecture, the operation of its individual functional blocks, and its algorithms.

Text processing involves a chain of operations, such as cleaning and normalising. Common text processing operations include: tokenization; removal of special characters; case conversion; spelling correction; removal of stop words; stemming; and lemmatization. In order to get the most out of LDA topic modelling, the acquired text corpus undergoes some pre-processing beforehand. The following procedures make up the text pre-processing pipeline:

a. Converting text to lower case Normalizing word and character capitalization help to reduce vocabulary size and generalize NLP pipeline.

b. Tokenization The process of tokenization disassembles phrases into their individual words. Word tokenization is crucial in text cleaning and normalisation, since it is the building block from which other operations may be carried out, such as stemming and lemmatization. c. Eliminating Non-Arithmetic Characters Non-alphanumeric symbols, such as symbols and special letters, add visual clutter and obscurity to free-form writing. Regular expressions are used to filter out certain characters.

d. Lemmatization New words may be created by appending a stem to an existing word. The inverse is also true for stemming. Words like learned, learning, and learner all have "learn" as their origin. The process of lemmatization is used to simplify words down to their root forms.

e. Taking out the commas Stop words are those that appear often in text but are typically of minimal practical value when attempting to uncover important qualities. The majority of the content you read contains stop words. 'A', 'an', 'the', and similar words are examples of stop words. In a topic model, these terms are filtered out since they are overused.

**Experimental Results**

UPRPAS and DPRPAS are two methods that are evaluated in this paper, and their respective experimental setups and data sets are described in depth. The outcomes of UPRPAS's paper subject modelling, reviewer expertise modelling, similarity computing, matching, rating, and assigning reviewers to papers are presented in this chapter. The outcomes of DPRPAS are presented, including those for text pair creation, text pair model design and training, relevance calculation, proficiency calculation, ranking, and assignment. The process includes a thorough examination of the proposed systems' performance and a detailed comparison to established, industry-standard benchmarks.

Since reviewer matches with a paper are often subjective and non-unique, evaluating the peer review system is a thought-provoking procedure for many reasons. For any particular document, there may be a number of reviewers who would do a good job. Reviewers who are a good fit for a manuscript are experts in the fields covered by the paper. Each manuscript-reviewer assignment combination must be manually assessed by an expert in order to establish a thorough prior ground truth against which system-generated assignments may be evaluated. The availability and accessibility of a large pool of subject matter experts in the areas covered by the manuscripts is crucial to the success of this strategy. This cannot be maintained for datasets of a sufficient size and breadth of subject matter. To address these issues, a topic-modeling-based automated hybrid assessment framework is presented to comprehensively evaluate each reviewer-manuscript assignment combination produced by the proposed system. An in-depth discussion of the data sets used, experimental design, outcomes, and assessment measures is presented before the main body of the paper.

**Datasets**

Due to confidentiality concerns, conference and journal editors seldom provide information about their reviewers' credentials or the criteria they employ to evaluate submissions for peer review. Here, information on reviewers and the papers they've authored are culled from scholarly databases like Google Scholar, ResearchGate2, and CiteSeer. Information about 106 reviewers and the papers they've critiqued are compiled for use in assessing UPRPAS and DPRPAS.

**Table 2: Coherence Score (Cv) and Perplexity (Pv) of Topic Models for Different Number of Topics**

| Dataset | NIPS2019 | | Interspeech2014 | |
|---|---|---|---|---|
| No. of Topics (K) | $C_v$ | $P_v$ | $C_v$ | $P_v$ |
| 5 | 0.3119 | -8.6089 | 0.4452 | -7.4443 |
| 7 | 0.3451 | -8.6227 | 0.4562 | -7.4614 |
| 10 | 0.3671 | -7.3443 | 0.47 | -7.4817 |
| 12 | 0.3856 | -8.1767 | 0.4599 | -7.47 |
| 15 | 0.4091 | -9.6167 | 0.4323 | -10.6798 |
| 18 | 0.4131 | -18.5601 | 0.4241 | -13.7885 |
| 20 | 0.4252 | -19.6795 | 0.4425 | -14.5383 |
| 25 | 0.4304 | -11.3786 | 0.4097 | -16.3147 |
| 30 | 0.4159 | -12.7028 | 0.4318 | -18.1167 |

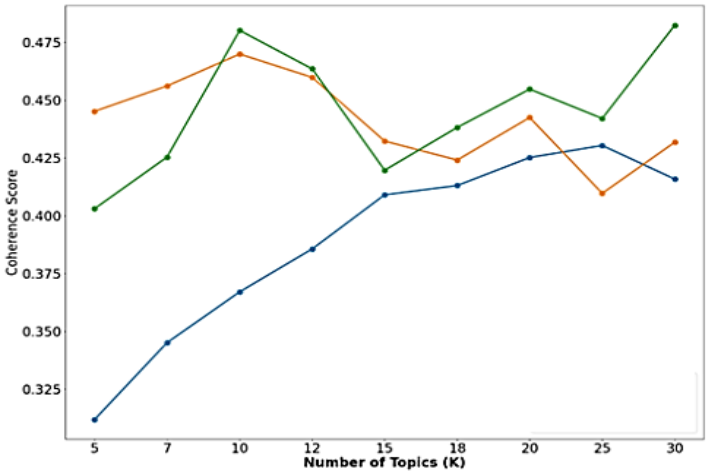


**Figure 1: Coherence Score against Number of Topics forNIPS2019, Interspeech2014 and AAAI2020 Datasets**

**Deep Learning-based Proactive Reviewer Paper Assignment System (DPRPAS)**

In this study, we introduce DPRPAS, a system that makes use of a word embedding and convolution neural network to calculate the relevance between a paper's research fields and the reviewer's publications. Modelling the connection between text pairs requires training data, and a novel approach to creating this data involves constructing training data as text pairs by producing alternative combinations of texts from different portions of papers and experts' publications.

The data set has been successfully constructed. Python and its associated libraries are used to successfully implement the proposed algorithms and systems. Extensive testing is performed to find the sweet spot for adjusting the settings and optimising the parameters. The system has been tested thoroughly, with positive outcomes and comparative analysis.

**A technique to build paper profile is developed using LDA**

A method for creating a paper subject model is devised. The method more precisely extracts the topic areas of submitted papers and the experts' publications. The paper's distinctive labelling of topics is based on these fields of study.The paper's originality is in its ability to generate topic labels that define several subject domains. Relevant subject labels were identified by selectively using text from throughout the manuscript, giving suitable weight to the keywords, and fine-tuning the LDA parameters. The end result is handwritten notes on paper papers**.**

**Conclusion**

An accurate subject model for submitted papers and reviewers is constructed as one of the results of the study effort, and a proactive reviewer article assignment mechanism is presented as a result. In addition, it finds and assigns the best reviewers to each publication, guaranteeing that load, coverage, and subject requirements are met. Everything happens automatically with zero need for involvement from humans. All phases of the study were completed with the stated purpose and goals in mind. Literature review, algorithm design, algorithm implementation, performance monitoring, comparison analysis, and result validation are all part of the process.

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