Journal of New Democratic Methods
An Introduction

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Abstract
This paper describes a new breed of academic journals that use statistical machine learning techniques to make them more democratic. In particular, not only can anyone submit an article, but anyone can also become a reviewer. Machine learning is used to decide which reviewers accurately represent the views of the journal’s readers and thus deserve to have their opinions carry more weight. The paper concentrates on describing a specific experimental prototype of a democratic journal called the Journal of New Democratic Methods (JNDM). The paper also mentions the wider implications that machine learning and the techniques used in the JNDM may have for representative democracy in general.

1 Introduction

Anyone can submit an article to an academic journal, but you can usually only become a reviewer if you are already well respected, or well connected, within the academic community. This paper describes a new kind of academic journal in which anyone can review articles submitted to the journal. Machine learning is then used to learn which reviewers accurately represent the views of the journal’s readers and thus deserve to have their opinions carry more weight.

This paper concentrates on describing a specific experimental prototype of a democratic journal called the Journal of New Democratic Methods (JNDM). When a submitted article is reviewed for the JNDM, the past performance of reviewers is used to predict the probability that, should it be published, the article will be acceptable to a majority of the article’s subsequent readers. Articles that are determined to have a probability of greater than a half of being acceptable are published.

Before formally defining what it means for an article to be acceptable, some definitions are required. In particular, suppose an article has m reviewers, then the reviews consist of a vector of binary values \( r = (r_1, \ldots, r_m) \) such that \( r_i = 1 \) if review \( i \) choose to accept the article and \( r_i = 0 \) otherwise. Similarly, if an article has n readers who express an opinion, then the opinions consist of a vector of binary values \( e = (e_1, \ldots, e_n) \) such that \( e_j = 1 \) if reader \( j \) thought the article was acceptable and \( e_j = 0 \) otherwise. A published article is said to be acceptable if a simple
majority of the article’s readers, who express an opinion, think it is acceptable,

\[
\text{acceptable} \equiv \sum_{j=1}^{n} e_j > \frac{n}{2}.
\]

Using the previous definitions, the task of deciding whether to accept an article is formally expressed as determining whether the conditional probability, given the reviews, that an article will be acceptable is greater than a half,

\[
P(\text{acceptable} \mid r) > \frac{1}{2}.
\]

To make the acceptance criterion stricter (or more lax), values other than a half could be used. Of course, other information about an article, such as the subfield or author, is also potentially important and is covered later in section 9.

2 Previous Work

The administrative tasks associated with running an electronic journal have already been automated by the Berkeley Electronic Press [1]. The associated software supports the traditional peer review model and is not freely available as open source code.

There has also been previous work specifically on automatically rating reviewers for academic journals using collaborative filtering techniques, for example see [2]. There is also a close connection with work that uses collaborative filtering techniques to suggest movies, books, music, etc. [3]. Typically, reviews are directly rated by their degree of “helpfulness” to the user. In contrast, the readers of the JNDM only see the results of the reviewing process, never the individual reviews themselves.

In addition, the goal of collaborative filtering approaches is usually to find new examples that match a person’s subjective tastes. There are, however, applications where subjective taste is not appropriate. For example, articles that appear in a scientific journal are supposed to express more than the subjective taste of the editorial board and reviewers. In particular, they are meant to embody some notion of objective quality. If they do not, then the scientific theories they espouse will founder upon their first encounter with reality. Of course, within the wide selection of high-quality academic articles that are available, there is still an important place for an individual’s personal preferences and interest.

The goal of the JNDM is not to help readers find articles that they are interested in, but to use reader’s feedback to produce better quality publications. Whether this really amounts to an important distinction is clearly open to question. The argument is that the democratic nature of the reviewing process allows input from a wider group of people and is thus more likely (on average and over time) to produce better quality results. The JNDM exists to see if this hypothesis is at least plausible. Even if the JNDM turns out to be a failure, the reasons for failure may turn out to have interesting ramifications for other democratic processes.

Another key difference between this paper and previous work is that it describes a working prototype, namely the JNDM. Trying to actually run a democratic journal should yield important insights into the associated challenges and possible solutions.

3 Submitting an Article

The process of submitting an article to the JNDM is straightforward and should be familiar to anyone who has electronically submitted an article to any other journal.
The author creates an account at the JNDM web site [www.democraticjournals.org](http://www.democraticjournals.org) and then submits her article. Currently, the article submission process leverages the existing e-Print archive at [arXiv.org](http://arXiv.org). That is, the author submits a link to her article that she previously uploaded to arXiv. The reason for this is twofold:

1. Until the JNDM website can build up enough history to automatically detect articles that qualify as “spam”, the arXiv site provides some minimum barrier to entry.
2. The current JNDM website has limited storage available to store large files.

Once an article is submitted to the JNDM, relevant information about the submission is stored in a database. After a fixed time period a decision is made, based on the received reviews, on whether to accept or reject a submission.

4 Reviewing an Article

Anyone can register at the JNDM web site and any registered user (not just authors) can retrieve a list of submissions that need to be reviewed. Some submissions will be closer to a decision being taken on whether to accept or reject and these appear at the top of the list. If an article does not receive enough (currently two) reviews in time, then it is rejected without prejudice and can be resubmitted.

When a user selects an article to review they are asked to recommend acceptance or rejection. In future, perhaps when more data is available, additional levels of gradation could be added but for now a binary decision is simplest. In addition, there is currently no mechanism to provide feedback to authors on why their submission was rejected or accepted. In future, feedback from reviewers who were influential in the decision to accept or reject a submission should be made available to authors.

Review results are also stored in a database and a reviewer can view their own previous reviews at any point. Provided the journal has not made a final decision on whether to accept or reject an article, a reviewer is free to alter or delete their own past reviews. Figure 1 shows a screen shot from an example page of the JNDM.

![Figure 1: Screen shot from an example page of the JNDM.](image)

If the JNDM becomes popular, additional security auditing will be required to en-
sure there is no way for unscrupulous users to obtain or alter restricted information contained in the journal’s database.

5 Reading and Rating an Article

Any registered user can read and rate any published article to express whether or not they feel the decision to publish an article was acceptable. Once again, the rating is (for now) a binary decision. Just like reviewers, readers can manage their past ratings and alter them if they change their minds or make a mistake.

Currently, there is no special action taken when a reader who was also a reviewer for an article expresses an opinion that is inconsistent with their review, for example, if a reader states an article is unacceptable that they previously recommended to accept. In future, inconsistencies should at least be flagged to the user to ensure they really did mean to change their mind.

6 Publication

As stated in the Introduction, an article is published in the JNDM if the conditional probability that it will be considered acceptable by a majority of the readers is, given the reviews, above a half.

Since each review is (at least, supposed to be) independent, and because it is one of the simplest thing to try first, Naive Bayes (see [4]) is currently used to calculate the probability that an article is acceptable. Note that, this paper therefore presents no new machine learning algorithms, just a novel application of known techniques. But, for the sake of completeness, the derivation of the required formula follows using the standard application of Bayes rule and the assumption of independent reviews:

$$
P(\text{acceptable} \mid r) = \frac{P(r \mid \text{acceptable})P(\text{acceptable})}{P(r)} = \frac{P(r_1 \mid \text{acceptable}) \cdots P(r_m \mid \text{acceptable})P(\text{acceptable})}{P(r)}$$

where the conditional probabilities $P(r_i \mid \text{acceptable})$ and the prior $P(\text{acceptable})$ are determined from historical data (see the next section). As usual, the final probability is computed by also calculating $P(\text{unacceptable} \mid r)$ and normalizing.

Naive Bayes was a reasonable choice to quickly bootstrap the JNDM into existence and is a good benchmark to beat, but there are, of course, many other machine learning techniques that could (and probably should) be used instead. For example, decision trees [4] and support vector machines [5] are both good candidates. You are strongly encouraged to submit an article to the JNDM containing your own opinions, objections, observations, improvements and alternatives. Ideas on algorithms and techniques to make the journal fairer and more resilient to exploitation are particularly encouraged.

7 Reviewers

As stated in the Section[4] after an article is accepted and published in the JNDM, people who read the article can express their opinion about whether the article deserved to have been published. Whenever a new publication decision must be taken, the opinions of the readers of each article are tallied and, if the number of
positive votes is greater than the negative votes, the article is labeled as acceptable. The label of acceptable, or unacceptable, is used to create the training set from which the probabilities \( P(r_i \mid \text{acceptable}) \) and \( P(r_i \mid \text{unacceptable}) \) are calculated using frequency counts. The prior \( P(\text{acceptable}) \) is just taken as the journal’s overall current acceptance rate.

| Article  | \( R_1 \) | \( R_2 \) | \( R_3 \) | \( R_4 \) | Acceptable? |
|----------|----------|----------|----------|----------|------------|
| Article 1| 1        | 1        | 0        | 0        | 1          |
| Article 2| –        | 0        | –        | 0        | 1          |
| Article 3| –        | 1        | 0        | 1        | 0          |
| Submission| 0       | 1        | 0        | 1        | ?          |

Table 1: Simple example of historical data.

In case you do not have a statistics or machine learning background, Table 1 shows a simple pedagogical example containing some made-up historical data. Articles 1 through 3 are articles that have previously been accepted or rejected and the “Submission” is the article that is currently being considered for publication. The reviewers \( R_1 \) through \( R_4 \) are the reviewers who submitted (for the current submission) reviews \( r_1 \) through \( r_4 \). The last line shows the results of those reviews (i.e., \( r = (0, 1, 0, 1) \)), and the previous lines show the reviewer’s decisions (if any) on previous publications.

From the table you can see that \( P(r_2 \mid \text{acceptable}) \), for example, is \( \frac{1}{2} \) and \( P(r_2 \mid \text{unacceptable}) \) is 1. In practice, a Laplace estimator is used in place of the frequency counts. Otherwise, especially when there is not much data, one of the individual probabilities can easily collapse to 0 which causes the whole multiplication in equation 1 to collapse to 0. For example, the frequency count gives \( P(r_4 \mid \text{acceptable}) = 0 \) whereas the Laplace estimator gives a probability of \( \frac{1}{3} \). In future, Lidstone’s estimator may be used instead of the Laplace estimator (see [6] if you want to be reminded about the Laplace and Lidstone estimators).

Currently, reviews are excluded from participating in the publication decision until the associated reviewer has recorded at least two previous reviews for published articles. The articles must have been published because (in the interests of author privacy and simplicity) there is no label for unpublished articles as readers never get to judge if they were correctly rejected.

### 7.1 Lead Reviewers

The precision of a reviewer is defined using the standard definition of precision, i.e.,

\[
\text{precision} = \frac{tp}{tp + fp},
\]

where \( tp \) is the number of true positives (articles that were correctly accepted by the reviewer) and \( fp \) is the number of false positives (articles that were incorrectly accepted). More sophisticated measures, such as the so-called F measure [6], can not be calculated because there is no information available about false negatives and true negatives.

The names of the reviewers with the highest precision (based on past performance) are published as the journal’s list of lead reviewers. Lead reviewers have the satisfaction of knowing that they have obtained the distinction democratically. Anyone can become a reviewer and if you consistently act as a good representative of the journal’s wider readership you can obtain the prestige of becoming a lead reviewer.
The open and democratic nature of the reviewing process should mean that the JNDM can quickly adapt to new kinds of submissions, or the changing abilities of reviewers. To improve the rate of adaptation, it might become necessary to weight reviewer's recent reviews more heavily than past ones. If so, then it would make sense to treat the whole problem of determining the weights assigned to reviews as an online learning problem and perhaps use techniques like those described in [7].

7.2 Automatic Reviewing

Eventually, the JNDM will make statistics available about which published articles were subsequently found acceptable by the readers. This allows machine learning programs to compete to become reviewers. That is, the task of predicting whether a published article will be found acceptable is a standard supervised learning problem. The training set consists of the published articles labeled by whether they were subsequently found acceptable or not. Machine learning algorithms that are trying to become reviewers have the difficult, but interesting, task of trying to analyze an article’s content to predict if it should be accepted. It will be fascinating to see how good an indicator a feature like an article’s author or affiliation are in correctly determining whether it should be accepted.

In an attempt for even further automation, a machine learning algorithm called the privileged reviewer will also be introduced. Just like the other reviewers, the privileged reviewer tries to predict which articles will be popular among readers. Unlike the other reviewers (including regular reviewers that are learning algorithms), the privileged reviewer is given access to privileged information about rejected submissions. In the standard tradition of academic journals, information about rejected submissions is not made public. Presumably, provided suitable privacy precautions are taken, authors will not mind rejection information being made available to a machine learning algorithm. If the privileged reviewer can become one of the lead reviewers then the need for any human input in the review process is reduced.

The software for the privileged reviewer will also be made open source and people will be encouraged to submit their own privileged reviewer algorithms. Within the confines of protecting author privacy, some kind of test harness will be made available for researchers to evaluate their designs for a privileged reviewer.

8 Editors

The editors of the JNDM are the SourceForge project administrators for the software that runs the journal’s web site. This software includes the code to learn which reviewers are most likely to give good reviews, and to decide, based on the reviews, whether an article should be published or not. The software is expected to constantly change (especially to start with) in response to problems that arise. For example, if a flaw is discovered in the software that could be exploited to make it easier to publish articles, then the editors would be responsible for fixing the flaw.

You will have noticed by now that, in the best traditions of computer science, the JNDM is wonderfully recursive. It is a journal about the very techniques that it uses to determine which articles to publish. Therefore, for inspiration on how to fix flaws and generally enhance the journal, it is expected that the editors will turn to ideas published in the JNDM itself. The idea that articles published in the journal feedback into the journal’s software to act as a sort of built in defense mechanism against abuse and subversion is appealing; it will be interesting to see how it plays out in practice.
Note that, even if the editors themselves become corrupt, self-serving or simply disliked, then (because all the journal’s software is open source and freely available) there is nothing to stop a new group of people using the journal’s software to establish their own journal with new editors who are more to their liking. The open source nature of the code behind the JNDM is therefore an important component (along with the machine learning) in making it more democratic.

9 Future Work

There is currently no restriction on an author reviewing their own articles. Of course, if they consistently give high reviews to their own work which later turns out to be unpopular, then they will soon lose their influence over the review process. Another alternative would be to create two pseudo-reviewers for each reviewer, one for reviewing their own work and another for reviewing the work of others. That way an unscrupulous, but otherwise competent reviewer could quickly lose all credibility for reviewing their own work, but keep their good standing for reviewing the work of others.

In theory, the appropriate use of pseudo-reviewers could automatically weed out other forms of bias, but it maybe easier to simply make authors anonymous. Pseudo-reviewers could perhaps be more useful for different subfields within the journal. That is, a reviewer could become a lead reviewer in their area of expertise but still feel free to try their hand at reviews in less familiar areas without penalizing their existing standing.

Readership opinion is only one possible source of information about the quality of articles published in the JNDM. Other possibilities include citations in other journals and publication or related articles in other journals. For example, publication in a prestigious journal of a rejected article could be used to label an article as incorrectly rejected.

There is also the possibility of establishing a journal entirely based upon benchmarks and challenge problems. That is, articles are only published if authors submit programs that perform well on some objective and freely available set of tests. This idea is already used informally by funding agencies and academic conferences who hold competitions to rate different research projects.

10 Conclusion

One of the biggest challenge to the success of the JNDM is obtaining participation from qualified people. This is a classic “chicken and egg” problem and hopefully the paper you are now reading will help to interest people. The more widely it can read the better.

Even if people begin signing up to the JNDM and submitting articles it will still be a challenge to encourage people to review and rate articles. It may be necessary to institute incentives to encourage people to actively participate. For example, users should probably not be allowed to read another submission until they have submitted their review for the last one. Similarly readers could be rationed to only being able to read a fixed number of articles without submitting any ratings. The danger is that a small number of enthusiasts end up doing all the reviewing with little or no feedback from the larger readership.

As the title suggests, the JNDM is not confined to articles about academic journals. An academic journal is just one example of an institution where objective quality
is important and a small group of people try to anticipate and guide the interests of a much larger group. Another interesting example is the whole notion of representative government and democracy. Finding a small group of individuals who can faithfully act as representatives for the people as a whole, and be successful at running the country, is what representative government is all about. The use of machine learning techniques as described in this paper, and (hopefully) to be described in forthcoming articles in the JNDM, could therefore have a profound effect on society at large.

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