Scoping natural language processing in Indonesian and Malay for education applications

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Abstract

Indonesian and Malay are underrepresented in the development of natural language processing (NLP) technologies and available resources are difficult to find. A clear picture of existing work can invigorate and inform how researchers conceptualise worthwhile projects. Using an education sector project to motivate the study, we conducted a wide-ranging overview of Indonesian and Malay human language technologies and corpus work. We charted 657 included studies according to Hirschberg and Manning’s 2015 description of NLP, concluding that the field was dominated by exploratory corpus work, machine reading of text gathered from the Internet, and sentiment analysis. In this paper, we identify most published authors and research hubs, and make a number of recommendations to encourage future collaboration and efficiency within NLP in Indonesian and Malay.

1 Introduction

Limited natural language processing (NLP) resources currently available for Indonesian and Malay varieties do not reflect large speaker populations of these languages in Indonesia, Malaysia, and other South-East Asian nations 1. Difficulties locating resources and existing work hinders progress in the field; it can result in duplicated or unnecessary work, clouding the ability of researchers to formulate useful research questions and study designs. Since Indonesian and Malay varieties are closely related (Sneddon, 2003; Basuki and Antaputra, 2020b), connecting research and technologies developed for either language could provide useful insights and shortcuts for work in the other language 2.

These challenges restrict the impact that advances in NLP might have in the education sector in Indonesia and Malaysia, and in the teaching of these languages. Ideally, teachers of Indonesian or Malay as a second or foreign language would draw on a wide range of human language technologies, machine learning methods, and corpus linguistics tools to enhance teaching and learning outcomes 3. As part of a broader project investigating teachers’ speech and materials for Indonesian language teaching (Maxwell-Smith et al., 2020; Maxwell-Smith, 2021), the aims of this study were to scope the state of play of existing work in Indonesian and Malay NLP to assist in the formulation of realistic research goals, and to identify useful networks and resources. As such, our study draws on the notion of scoping work as “reconnaisance” (Peters et al., 2015), where the goal is to first determine what range of quantitative and/or qualitative evidence is available on a topic and then to chart, map, or otherwise represent this located evidence visually.

Our research questions were as follows:

1. What language technologies and NLP resources exist for Indonesian/Malay (and therefore for education sector applications)?
2. How do they align with the trends seen more widely in NLP?

We begin by describing our search strategy and methods for charting 657 included studies by their

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1In 2011, the Indonesian Census recorded 197 million Indonesians as literate in Indonesian (Zein, 2020). In Malaysia, nearly the whole population speak Malay as a first or additional language (Coluzzi, 2017); in 2021, according to the Department of Statistics Malaysia, this was about 32 million people.

2As indicated in Lin et al. (2019c) and Nomoto et al. (2018a), some significant differences should caution NLP researchers from regarding the Indonesian and Malay languages as one.

3See for example Lee et al. (2020) in journals such as CALL and LLT.
2 Methods

In order to capture a broad and rich picture of the recent literature, we applied a simplification of the Systematic Reviews and Meta-Analyses (PRISMA) for scoping reviews (Tricco et al., 2018; Page et al., 2021). Generally, we aimed to provide a descriptive overview and visualization of the reviewed material without detailed critical appraisal of individual studies or synthesis of evidence from different studies (Pham et al., 2014; Peters et al., 2015).

The review engaged with literature from many disciplines, including, but not limited to, Computational Linguistics, Computer Science, Indonesian Language Teaching, and NLP. Extensive consultations with research librarians resulted in a broad search strategy of the databases and terms (Figure 2). Both Indonesian/Malay and English search terms were used to maximize coverage. Additional search terms focused on our interest in Indonesian language teaching were used to mitigate the risk of missing relevant literature.

We experienced significant problems identifying studies with the Association for Computational Linguistics (ACL) as their publisher. In searches via Google Scholar, Scopus, and Proquest; many ACL publications (e.g., Koto et al. (2020a) and Wilie et al. (2020)) were not returned. We then added a direct ACL Anthology search to our database search list. Unexplained behaviour in the ACL Anthology sort by ‘Year of Publication’ functionality cut results by over 400%, missing, for example, the aforementioned two relevant papers. To identify a reasonable portion of the work presented at ACL events, we extended the set of identified records semi-automatically by manually opening and exporting studies from ACL Anthology searches.

Our inclusion criteria specified that studies be recent (published in 2016 or later), peer-reviewed, written in English, Indonesian or Malay, and relevant to our topic (work about other languages or unrelated to NLP was excluded). Topical relevance was determined by a single reviewer (the first author of this paper) screening the title, abstract, and metadata of each identified study ($n = 1,954$) that was unique ($n = 1,510$) (Figure 1).

Included studies were then classified according to Hirschberg and Manning’s 2015 characterization of advances in NLP. We refer to these classifications in brief as: Broad NLP; Machine Reading; Machine Translation; Spoken Dialogue Systems; Speaker State; and Social Media. We added a class — Statistical Work — to group work which primarily contributes corpus data or statistical and pre-processing work which stands at the foundation of most NLP.

Two reviewers (the first and last author of this paper) worked as a classification team, thereby assuring the quality of this ‘light-touch’ manual content analysis (Saldaña, 2016). In total, 80 of the 657 included studies (12.2%) were classified independently by both reviewers, including studies whose classification was perceived as uncertain by the first reviewer, as well as a random selection of further studies to increase confidence in reviewer agreement. Reviewers’ classification disagreements were resolved through reference to full-text articles and discussion reaching consensus.

While many studies were classified as belonging to more than one ‘grouping’, the primary class was...
used in our analysis below. Appendix B is sorted by the second and third classification levels to improve search-ability and provide further information.

A search of titles and abstracts uncovered pre-existing reviews. These reviews were screened in full text and their findings are outlined in our results section to complement the scoping or quantitative map of the field. Literature outside our inclusion criteria which appeared highly relevant was retained separately for full-text review.

Unique names in the raw list of the top 50 most-published authors were manually normalized to prepare a publication-by-author count. Manual identification of name variants for authors with many publications were identified by matching author initials, affiliations, and profiles where possible to create Figure 5. Author affiliations for Figure 6 were taken from the most recent study of a given author included in this overview.

## 3 Results

A total of 657 from 1,954 studies met our inclusion criteria. Statistical and corpus work dominated throughout the last 5 years (from 2016 — Figure 3). Studies related to machine reading and sentiment analysis of online text such as news websites (included in ‘Speaker States’) and social media (sentiment analysis comprises much of our ‘Social Media’ classification) were popular and showed growth (Figure 4). The largest growth area was in ‘Speaker Dialogue Systems’ with a relative boom in publishing in 2019 (26 studies).

While our search terms were bilingual, the majority of studies that met our inclusion criteria were written in English or had an English title and abstract. The apparent stagnation of publications in 2020 (Figure 4) with a rebound in the first half of 2021 (which our search covered) could be related to the context of the COVID19 pandemic.
However, as “country-specific variables play a significant role” (Abramo et al., 2022) in pandemic publication trends, this is very difficult to determine.

As noted by Hirschberg and Manning in 2015, machine reading research makes use of the vast quantities of text available in the modern world while the mining of text from social media has “revolutionized the amount and types of information available today to NLP researchers”. The presence of work in all classifications indicates Indonesian and Malay NLP has advanced from its 2015 state, when Hirschberg and Manning said it had “no such resources or systems available” (2015). To complement the quantitative picture in Figures 3 and 4, we identified existing reviews and provide a summary below. A detailed full-text review of all articles identified in a given classification is needed to fully investigate progress in each respective field.

3.1 Existing Reviews

Of the included studies, 15 were identified as reviews and read in full-text. Lan and Logeswaran (2020) discussed NLP in Indonesian/Malay in general. They did not identify their search methods nor their inclusion criteria, and their reference list had a strong focus on Malaysian research. Their description of statistical work on morphological and lexical analysis, the development of stop word lists, text normalization and named entity recognition concluded that “most researchers have no choice but to resort to compile their own corpus specific to their domain” (Lan and Logeswaran, 2020). According to their discussion, applications of NLP, such as those for machine translation, sentiment analysis, sarcasm and spam detection, as well as text summarization, were hampered by an absence of language-specific tools and resources. For example, they stated that the Jawi Malay script (which is based on Arabic) appeared to be missing characters, lemmatizers for translation seemed to struggle with affixes as they were loaned from English NLP, and sentiment analysis tended to rely on translated sentiment lexicons.

A 16th review article — “An Overview of Natural Language Processing for Indonesian and Malay” by Jiang et al. (2020), written in Mandarin — was identified at the screening stage. It fell outside the scope of this study but we did note that it provided a detailed overview of Indonesian/Malay NLP. The authors characterized the field as “widely distributed, covering stemming, part-of-speech tagging, syntactic analysis, semantic analysis, and other underlying technologies, as well as upper-level applications such as machine translation, spell checking, sentiment analysis, named entity recognition” (Jiang et al., 2020). However, similarly to Lan and Logeswaran (2020), they noted that “the basic resources, open data platforms and open-source language processing tools for these two languages are also lacking, and there are few mature and available text analysis systems” (Jiang et al., 2020).

Statistical or corpus based NLP is important to further the field; however, only 2 reviews had a special focus on corpora and these were specific to Malay (Awang Abu Bakar et al. (2018) and Nasharuddin et al. (2018)). These reviews provided
some insight into Malay resources, and Nasharuddin et al. (2018) suggested document alignment as an avenue to overcome parallel corpus scarcity in cross and bilingual information retrieval, however, a thorough picture of existing corpora was lacking. A further review by Kassim et al. (2016b) discussed morphology related challenges in stemming tools for Malay as perceived by the authors. However, this review did not fully address the complex steps necessary to uncover lemmas. As later described by Nomoto (2020), what has been “thought of as stemming and lemmatization [...] is in fact ‘root’-ing, that is, undoing all morphological processes to get a root”. Future work needs to make use of the sort of stem and lemma information in MALINDO Morph to create Indonesian/Malay stemmers.

Machine translation was discussed in a single review of Indonesian translation by Rahutomo et al. (2019)6, who identified that many researchers had created their own web-crawled parallel corpora. They described a range of techniques used in Indonesian translation, noting that Moses was commonly used and that attention-based approaches were improving neural machine translation. Their list of studies spanned languages: Sundanese, Japanese, Lampung, as well as English, Japanese, and Korean — a very limited list given there are between 652–701 languages in use in Indonesia (Zein, 2020). Thereby translation needs are yet to be met.

Machine reading was the focus of 5 reviews. Gunawan and Amalia (2018) reviewed single document text summarization and identified evaluation methods as a significant concern among 10 papers reporting research into extractive text summarization. They concluded that a text-summary dataset created by experts is needed to advance the field and to calibrate the diverse results reported in the literature.

Looking only at Malay, Mohemad et al. (2020b) suggested relatively poor results across the field. They found summaries were often longer than the original text and Malay anaphora proved difficult to condense, resulting in poor comprehensibility.7

In 2021, Widodo et al. remained concerned with evaluation measures in text summarization. Their review of 6 studies found all text summarization work was in extractive summarization — as opposed to abstractive — and that it was dominated by single document summarization of online news. To expand the usability and scope of these tools for Indonesian, they suggested that journal articles should be used as data to support multi-document summarization, as existing summaries of these documents could be used to enhance results.

Malay named entity recognition and classification (NERC) was carefully reviewed by Mohemad et al. (2020a), finding that differences in Malay morphology and textual ambiguities, as well as limitations on corpora and annotated data, are difficult challenges affecting both rule-based and machine learning methods. In addition, they found that the “majority of the systems developed [were] based on manually predefined dictionaries by a human” (Mohemad et al., 2020a) and that deep learning methods were yet to be studied with Malay NERC.

All 4 reviews of sentiment analysis were primarily concerned with social media in the Malaysian context (see both ‘Speaker States’ and ‘Social Media’ in Appendix B). Abdullah and Rusli (2017) found hybrid approaches of lexicon based and supervised machine learning were most common, while Handayani et al. (2018) added a more detailed discussion of techniques and datasets found in 10 carefully selected studies. Abu Bakar et al. (2020) foregrounded the ‘noise’ of social media data to confront the more complex language often found on the Internet. Abdullah and Rusli (2021) pushed this further, examining literature on multilingual sentiment analysis to inform the development of sentiment analysis for the Malaysian social media context, which they described as characterized by the multilingual use of English, Malay, and Chinese.

No reviews of spoken dialogue systems, such as automated speech recognition (ASR) or Text To Speech (TTS) toolkits (which are typically considered later-generation NLP), were found. This is not surprising given text-based NLP (e.g., machine reading) dominated the research agenda (Figure 4).

3.2 Notable Work Responding to the Lack of Data and Evaluation Methods, and Other Recent Contributions

Common to all reviews was a scarcity of freely available NLP resources, and subsequently the creation of custom datasets, loaned preprocessing tools from NLP in English, and difficulties in benchmarking performance without reliable eval-

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6See also Septarina et al. (2019)

7Providing a brief reference to Malay language corpora, Omar et al. (2021) outlined advances in text summarization techniques.
uation techniques and reference datasets. In this context, we note the growing use of zero and few shot methods which are supported by pipelines such as HuggingFace\(^8\). We also note four projects and respective papers that develop benchmarking and open access corpora for:

- language modelling; Indonesian Language Evaluation Montage (IndoLEM) and Indonesian Bidirectional Encoder Representations from Transformers (IndoBERT);
- Indonesian Natural Language Understanding (IndoNLU); as well as
- Indonesian Natural Language Generation (IndoNLG) and Indonesian Natural Language Inference (IndoNLI).

Recently available, but not included in our study as it was published after our analysis was complete, Aji et al. (2022) provide a detailed discussion of NLP for the 700+ languages spoken in Indonesia. They outline challenges for NLP in Indonesia, describing limited resources, language diversity, orthography variation, and societal challenges such as the poor distribution of technology and education across Indonesia.

3.3 Highly Active Researchers and Research Hubs

Highly active researchers in the field are identified in Figure 5. While we made substantial efforts to ensure author publications were grouped accurately, name variations appeared to be prevalent in this field. We concentrated our efforts on normalizing the raw list of the top 50 authors. In contrast to broader trends (Mohammad, 2020), we note that 7 of the 11 authors in Figure 5 are female, though some are not first authors on many papers.

Research hubs in Indonesia and Malaysia are illustrated in Figure 6. The affiliations of the 25 authors with the most publications were used to identify these hubs. All affiliated universities listed by these 25 authors (as indicated in their most recent publication which met our inclusion criteria) were in either Malaysia or Indonesia. While there was an even spread between the two countries, overall Malaysia dominated with a ratio of 14:11 affiliations in Malaysia and Indonesia, respectively.

3.4 Education Specific Studies

The number of education specific studies was 41 (see Appendix A), based on the title and abstract. Of these 41 studies, 15 focused on assessment, with an emphasis on expediting and improving the efficiency of grading and providing feedback. Earlier studies (2016–2018) tended to focus on word-level error correction and short-answer grading while later studies (2019–2021) seemed to address whole of text evaluation, assessment task design (particularly questioning techniques), and providing feedback. Within the limited time frame of our study, we tentatively noted a shift from micro language level applications and their intrinsic evaluations to more macro, holistic language use applications that proceed to extrinsic or broader NLP evaluations.

A portion of education studies considered teaching practices and teacher training. Generally the studies reflected the design of our search-terms to target Indonesian language teaching; 10 papers were geared towards using NLP to improve the teaching and learning of Indonesian/Malay for non-background language learners. Bahasa Indonesia bagi Penutur Asing (BIPA — Indonesian language for Foreign Learners) and the Malay equivalent were discussed separately. Two studies were related to using NLP to improve the training of teachers of Indonesian as a foreign language. Another 2 studies focused on NLP for improving the teaching of translation for local students (i.e., Indonesian background speakers). Beyond studies from a language teaching setting, a further 6 studies related to instruction in general or other areas of the curriculum such as Mathematics, study skills, and values education.

Overall the body of work indicates a need for greater resourcing generally, and greater resourcing in education, with a shift towards more sophisticated language concerns and potential uses for these methods. Pleasingly, researchers identified for a high number of publications in Figure 5, such as Amalia, A\(^9\) were also identified among those developing NLP for education (Amalia et al., 2019a), indicating high profile NLP researchers are invested in education sector applications.

4 Discussion

This study sheds significant light on the state of play and progress of Indonesian and Malay NLP.
We make the following 7 recommendations and outline our related contributions to encourage collaboration and support appropriate investment in the development of Indonesian and Malay NLP, and its application in education.

### 4.1 Recommendations

1. **Broader adoption of best-practices for findable, open, sustainable, and future-proof data.** All 15 reviews raised the difficulty of locating data, tools, and existing work as a significant problem. Our study responds to this problem and is unique in that Appendix B offers a catalogue of recent work, identifies a variety of openly shared datasets and tools, and locates research hubs. Our results complement reviews such as Lan and Logeswaran (2020) and Jiang et al. (2020) by providing an empirical picture of published research on Indonesian and Malay NLP. While our study was not specifically focused on corpora like Awang Abu Bakar et al. (2018), over 50 of the papers listed at the top of ‘Statistical Work’ in Appendix B point to
datasets which may be useful to future projects.

Useful advice to implement the FAIR Principles (Findable, Accessible, Interoperable, Reusable) and further advice for individual researchers/teams to develop metadata, choose file formats, and think beyond their immediate plans for linguistic data is set out by Janda (2022) and Mattern (2022), respectively. Funding requirements that encourage data reuse (given ethics restraints) and which provide financial support for adequate digital stewardship are recommended.

2. Expanded evaluation methods and datasets, and negative result publication

As identified by Gunawan and Amalia (2018) and Widodo et al. (2021), evaluation of Indonesian and Malay NLP is poorly supported due to a lack of clear methods and few reference datasets. Open, accessible data from studies can assist with this, but to encourage further efficiency in the field, we also recommend authors consider the publication of ‘unsuccessful’ experiments in venues such as Workshop on Insights from Negative Results in NLP and organize or participate in evaluation challenges (a.k.a. shared tasks) and their workshops, for example, as part of ACL conferences.

3. Collaboration and connection between Indonesian and Malay NLP research and projects to speed development and allow cross-fertilisation

Many of the reviews discussed in our results focused on Malaysian research specifically looking at Malay NLP. By using both Indonesian and Malay in our search terms we connect these reviews to the work of Indonesian authors. To illustrate, Handayani et al. (2018), Abu Bakar et al. (2020), and Abdullah et al. (2021) examine one study which included Malay in the application of multilingual sentiment analysis. Our findings connect this work in Malay to more recent work by Tho et al. (2021), who looked at Indonesian and Javanese code-mixed sentiment analysis.

Indonesian and Malay are closely related (Sneddon, 2003). With a caveat that corpus metadata must clearly describe which languages are present, and that projects must clearly state how Indonesian and Malay are used in training data, we recommend future work seek out synergies that could be leveraged by using both languages.

4. Flexible author name formats and consistent author name use

Many authors of studies we included had only one name, but appeared to double this name in some publications but not others, perhaps to suit forms built with an (eurocentric) expectation of family names. Similarly, many authors with lengthy names used various forms.

We recommend publishers adapt their submission forms to accommodate diverse name traditions and support existing unique author identifiers (e.g., the ORCID system). We also recommend authors choose a publication name and use it as consistently as possible to increase the findability of their work.

5. Investment in spoken language data and transcription protocols

Our findings indicate only modest developments of ‘later-generation’ NLP in Indonesian and Malay. Significant investment is needed to give users of these languages access to a broader gamut of NLP applications, including applications in the education sector.

In this space it is also essential to recognise differences in the actual usage of these languages in real-life, spoken situations. Transcription which records code-mixed and often diglossic use of spoken varieties of Indonesian and Malay in a machine readable format needs to be investigated and scrutinised (Maxwell-Smith et al., 2020).

6. Investment in other languages of Indonesia and Malaysia

As a necessary endeavour for equitable access to advances in NLP for speakers, and to limit the further endangerment of many languages as a consequence of the expansion of Indonesian (Zein, 2020), we recommend simultaneous investment in other languages of Indonesia and Malaysia. Linked to Recommendation 5, to reflect actual usage and to allow NLP to be useful in real-world contexts where code-mixing is the norm, investment in other languages is also likely crucial.

7. Education and NLP researchers should consider the use of datasets by researchers outside their field

A research project such as ours, investigating teacher-speech and teaching materials for Indonesian language teaching (Maxwell-Smith et al., 2020) should take advantage of human language technologies. This article contributes a language-specific characterization of the field which will help scope future projects.

Education researchers should be aware that computational methods such as data normalization scripts and stemming tools are yet to be fully de-
veloped for their use with the Indonesian language. If working with spoken language, ASR toolkits for working on low resource languages are suitable for consideration but may require significant investment of time and training before they are capable of managing complex code-switching behaviours common in education settings.

For education researchers and teachers to use NLP resources they need clear information about the profile of language/s in corpora and also about what data has been used when training models/tools. This allows proper assessment of the cultural and political suitability of NLP resources. Education researchers also need to consider the possible use of datasets by researchers outside their field. Ensuring data they collect is recorded in ‘future-proof’ formats and prepared with consideration of the FAIR principles (see Recommendation 1 — Janda (2022) and Mattern (2022)) is an investment which encourages NLP applications specifically built for or amenable to education settings.

4.2 Limitations and Future Work

With regard to the limitations of this study, we employed a ‘light-touch’, subjective coding method with a discrete set of class labels to scope relevant literature; we did not undertake the act of synthesis (Peters et al., 2015). We screened only the title and abstract for the vast majority of references. Unintentional misinterpretation could have taken place. Our analysis provides an approximate area within NLP for each reference to assist researchers studying an NLP application or use-case. Researchers interested in a particular algorithm (e.g., Random Forest Decision Trees or Transformers), or the use of a particular performance indicator (e.g., F1 or Word Error Rate), might not find our work as useful, but we encourage them to scan related categories in Appendix A for work relevant to their interest. Most references were labelled as belonging to multiple categories, with the identification of the first category an educated but ultimately subjective decision. Reading every study carefully beyond title and abstract was beyond the scope of this study.

Future studies to target Indonesian and Malay language publications may identify further literature on Indonesian and Malay NLP. Unfortunately, our initial searches through databases such as the University of Indonesia’s Research Portal, produced varied results, with a large proportion of returned studies not necessarily having been as rigorously peer-reviewed (encompassing for example many ‘skripsi’ or honours dissertations). Indonesia’s national library service OneSearch has grown dramatically, and with over 3748 libraries affiliated in February 2022, it should also be included in future reviews of Indonesian and Malay NLP.

Since we conducted our review, Aji et al. (2022) have proposed potential research directions in the Indonesian context such as data-efficient and compute-efficient NLP. Given the low number of studies in our Speaker Dialogue Systems class, we support their call for “NLP Beyond Text”. The ‘superglossic’ translanguaging practices of Indonesia (Zein, 2020), and language classrooms (Maxwell-Smith et al., 2020), correspond with their call for “Robustness to Code-mixing and Non-Standard Orthography”. Applications of Indonesian NLP necessitate involvement with other languages of Indonesia and inevitably impact many at-risk languages. There is an ethical obligation for “careful assessment of individual usage scenarios of language technology, so they are implemented for the good of the local population” (Aji et al., 2022).

5 Conclusion

Overall, this scoping study provides a baseline picture of Indonesian and Malay NLP. It shows an emerging research community engaged with the wide range of NLP advances identified in 2015 by Hirschberg and Manning. Researchers in the field continue to experience difficulties in benchmarking performance without reliable evaluation techniques and reference datasets, re-engineering of loaned preprocessing tools from English NLP, and thankless tasks such as the creation of custom datasets and resources. NLP applications in education are limited, as are tools for language which is not in text format. Our results highlight the importance of creating and releasing well-described and maintained resources openly and fostering collaboration. IndoLEM-IndoBERT, IndoNLU, IndoNLG, and IndoNLI are notable releases that are already helping to orientate researchers and future projects using Indonesian and Malay NLP.

Acknowledgements

We are grateful to Murray Hall, Chenchen Xu, and Rebecca Barber for their technical, translation, and search strategy assistance, respectively. We also thank the anonymous reviewers for their helpful feedback.
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## A Appendix

A more accessible table will be available [here](#).

### Table 1

| Title                                                                 | Author                        | Year |
|---------------------------------------------------------------------|-------------------------------|------|
| The Development of an Audible Pattani Malay…                       | Boonkwan et al.               | 2016 |
| A corpus platform of Indonesian academic language                   | Kwary                         | 2019 |
| U-tapis: Automatic spelling filter as an effort to…                | Mediyawati et al.             | 2021 |
| Word level auto-correction for latent semantic…                    | Ratna et al.                  | 2017 |
| The development of Indonesian POS tagging sys…                     | Muljono et al.                | 2017c|
| A morphophonemic analysis on the affixation in…                    | Ampa et al.                   | 2019 |
| Learning Indonesian Frequently Used Vocabulary…                    | Lin et al.                    | 2019b|
| Towards developing colloquial Indonesian lan…                      | Nataprawira and Carey         | 2020 |
| Pengajaran bahasa dan penerolehan bahasa ke…                       | Rosiyana                      | 2020 |
| Cross-corpus native language identification via…                   | Rangel et al.                 | 2018 |
| Acquiring Extended Units of Meaning: The Role…                     | Suhardijanto and Putra        | 2019 |
| Designing Phonetic Alphabet for Bahasa Indone…                     | Karlina et al.                | 2020 |
| Indonesian essay grading module using Natural…                     | Ajitino and Widyani           | 2017 |
| Automated Bahasa Indonesia essay evaluation…                       | Amalia et al.                 | 2019a|
| Exploiting Syntactic Similarities for Preposition…                | Irmawati et al.               | 2016 |
| Vocabulary Load on Two Mainstream Indonesian…                      | Destiani et al.               | 2018a|
| Perbandingan Deiksis pada Dua Buku Ajar: Anal…                     | Destiani et al.               | 2018b|
| Pengembangan kamus pemelajar Bahasa Indone…                        | Fadly                         | 2018 |
| Teaching Specific Purpose Translation: Utiliza…                    | Siregar                       | 2017 |
| Theme markedness in the translation of student…                   | Sofyan and Tarigan            | 2018 |
| Strategi Pengukuran Upaya Berbahasa Menerusi…                      | Redzwan et al.                | 2020 |
| Generating artificial error data for Indonesian…                   | Irmawati et al.               | 2017b|
| Menangani Kekaburan Kemahiran Prosedur dan…                       | Anida et al.                  | 2019 |
| Environmental awareness content for character…                    | Rahmawati et al.              | 2020 |
| Inquisitive semantic analysis of Malay language…                   | Subet and Md Nasir            | 2019 |
| An experimental study of text preprocessing tech…                  | Hasanah et al.                | 2018 |
| N-Gram Keyword Retrieval on Association Rule…                      | Setiawan et al.               | 2018 |
| Semi-supervised learning self-training for Indone…                 | Wulan and Supangkat           | 2018 |
| Evaluating rnn architectures for handling imbal…                   | Christianto et al.            | 2020 |
| A comparison of supervised text classification…                   | Dhammajoti et al.             | 2020 |
| Automatic Indonedia’s questions classification…                    | Kusuma et al.                 | 2016 |
| Answer categorization method using K-means for…                    | Ratna et al.                  | 2019 |
| Knowing Right from Wrong: Should We Use…                           | Septiandri et al.             | 2020 |
| WPS: Application for Generating Answer of…                         | Oktavia et al.                | 2021 |
| Question generation model based on key-phrase…                     | Wijanarko et al.              | 2021 |
| Developing Question Generation System for Ba…                      | Wisnu Prabowo et al.          | 2021 |
| Applications of natural language processing in…                    | Maxwell-Smith et al.          | 2020 |
| Developing an online self-learning system of In…                   | Muljono et al.                | 2016 |
| Automatic Pronunciation Generator for Indone…                      | Hoesen et al.                 | 2019 |
| Anita: Intelligent Humanoid Robot with Self…                        | Andreas et al.                | 2019 |
| A novel model and implementation of humanoid…                      | Budiharto et al.              | 2021 |

End of Table
## B Appendix

A more accessible table will be available here.

### Table 2

| Title                                                                 | Author                          | Year  |
|----------------------------------------------------------------------|---------------------------------|-------|
| IndoLEM and IndoBERT: A Benchmark Dataset                            | Koto et al.                     | 2020b |
| Unstructured Malay Text Analytics Model in Crime                      | Mohemad et al.                  | 2020c |
| A new framework for information system development                   | Sukarsa et al.                  | 2018  |
| An overview of BPPT’s Indonesian language resources                  | Gunarso et al.                  | 2016  |
| Challenges and development in Malay natural language processing      | Lan and Logeswaram              | 2020  |

| Title                                                                 | Author                          | Year  |
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| The Development of an Audible Pattani Malay-English corpus           | Boonkwan et al.                 | 2016  |
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| Characteristics of Malay translated hadith corpus                    | Sazali et al.                   | 2020  |
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| Examining the writing genre in journal articles of Malaysian Malay   | Wiratno and Dzakiria            | 2016  |
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| Introduction of the Asian Language Treebank                          | Riza et al.                     | 2017  |
| Information extraction: Evaluating named entity                      | Sazali et al.                   | 2017  |
| Comparative study on corpus development for Malaysian Malay           | Din et al.                      | 2017  |
| Building the Pornography Corpus for Bahasa Inini                      | Gunawan et al.                  | 2019c |
| Building a Malay-English code-switching subject                       | Kasmuri and Basiron             | 2019  |
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| Development of a retrieval system for Al Hadith                       | Aulia et al.                    | 2017b |
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| The Development of the Malaysian Hansard Core                        | Abdullah et al.                 | 2021  |
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| Tufs asian language parallel corpus (talpco)                         | Nomoto et al.                   | 2018b |
| Sentence segmentation and phrase strength estimation                 | Hanum and Bakar                 | 2016b |
| Evaluation of Energy and Duration on Malay                           | Hanum and Bakar                 | 2016a |
| Prosodic breaks on Malay speech corpus: Evaluating                    | Hanum et al.                    | 2017  |
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| Stress predictors in a Papuan Malay random forest                    | Kaland et al.                   | 2019  |
| Lexical analyses of the function and phonology                       | Kaland et al.                   | 2021  |
| Development of under-resourced Bahasa Indonesia                       | Cahyaningtyas and Arifianto     | 2018  |
| Generative Indonesian Conversation Model using Malay                  | Chowanda and Chowanda           | 2018  |
| An evaluation of sentence selection methods on Malay                  | Muljono et al.                  | 2020  |
| Indonesian Affective Word Resources Construction                      | Hulliyah et al.                 | 2019  |
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| Building a web-based application for language ...                    | Dinakaramani and Suhardijanto        | 2019 |
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| Evaluating the use of word embeddings for part- ...                  | Abka                                 | 2017 |
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| Incorporating Knowledge Base in Unsupervised ...                     | Rifin and Hamzah                    | 2017 |
| Movie Summarization based on Indonesian Subti ...                     | Situmeang et al.                     | 2019 |
| Semantic similarity measures for Malay-English ...                  | Mahadzir et al.                      | 2018 |
| Recognizing and normalizing temporal expres ...                       | Mirza                               | 2016 |
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| Rapid Heteronym Disambiguation for Text-to- ...                      | Samsudin and Rahim                  | 2019 |
| Identification Of Features In Predicting Promi ...                   | Tiun and Hong                        | 2020 |
| An Enhancement of Malay Social Media Text ...                        | Bakar et al.                         | 2019 |
| Text Normalization Algorithm on Twitter in Com ...                   | Hanafiah et al.                      | 2017 |
| Pre-processing Tasks in Indonesian Twitter Messages ...              | Hidayatullah and Ma’arif             | 2017 |
| Proposal: A Hybrid Dictionary Modelling Ap ...                        | Nor Azlizawati Binti et al.          | 2017 |
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| Review and Visualization of Facebook’s FastText ...                  | Young and Rusli                      | 2019 |
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| Categorization of Malay social media text and ...                   | Maskat and Rahman                    | 2020 |
| Exploring Edit Distance for Normalising Out-of- ...                  | Raja et al.                          | 2019 |
| An automatic construction of Malay stop words ...                    | Chekima and Alfred                  | 2016 |
| Word Sense Disambiguation in Bahasa Indonesia ...                    | Faisal et al.                        | 2018 |
| Cross-Lingual and Supervised Learning Ap ...                         | Mahendra et al.                     | 2018b|
| Title                                                                 | Author                           | Year  |
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| Enhancing Latent Semantic Analysis by Embed...                       | Rahman et al.                    | 2017  |
| Word level auto-correction for latent semantic...                    | Ratna et al.                     | 2017  |
| Evaluating Word Embeddings for Indone...                             | Rizal and Stymne                 | 2020  |
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| Naïve Bayes implementation into Bahasa Indone...                     | Jodhinata and Hartanti           | 2016  |
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| Stemmer and phonotactic rules to improve n-gram...                   | Suyanto et al.                   | 2021  |
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| Comparison of stemming algorithms on Indone...                       | Rizki et al.                     | 2019  |
| Improvement on stemmer algorithm for Indone...                       | Syawanodya and Huda              | 2018  |
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| Semantic Role Labeling in Conversational Chat...                     | Rachman et al.                   | 2018a |
| POS-Tagging for informal language (study in In...                    | Suryawati et al.                 | 2018  |
| Part-of-speech tagger for Malay social media texts                   | Ariffin and Tiun                 | 2018  |
| A comparison of different part-of-speech tagging...                  | Amrullah et al.                  | 2017  |
| Indonesian part of speech tagging using hidden...                    | Cahyani and Vindiyanto          | 2019  |
| Part-of-speech (pos) tagger for Malay language...                    | Gaber et al.                     | 2020  |
| Part of Speech Tagging for Indonesian Language...                    | Handrata et al.                  | 2019  |
| Evaluating the Morphological and Capitalization...                   | Manik et al.                     | 2019  |
| Morphology analysis for Hidden Markov Model...                       | Muljono et al.                   | 2017a |
| POS-tagging for non-English tweets: An auto...                       | Munandar et al.                  | 2017  |
| An evaluation of MorphInd’s morphological an...                      | Prihartoro                       | 2021  |
| Rule-based Part of Speech Tagger for Indonesian...                   | Purnamasari and Suwardi          | 2018  |
| Evaluating Istm networks, hmm and wfst in...                        | Tan et al.                       | 2017b |
| Time Series Neural Network Model for Part-of-...                      | Tanadi                           | 2018  |
| Implementation of ontology-based on Word2Vec...                      | Togatorop et al.                 | 2020  |
| Utilizing Morphological Features for Part-of-...                      | Trisna et al.                    | 2020  |
| On Empirical Evaluation of Deep Architectures...                     | Yuwana et al.                    | 2019  |
| On part of speech tagger for Indonesian language                    | Yuwana et al.                    | 2018  |
| Identifying Sentence Structure in Bahasa Indone...                   | Gunawan et al.                   | 2019d |
| Breakdown film script using parsing algorithm                        | Wahana et al.                    | 2020  |
| Algorithm for simple sentence identification in...                   | Anggraini et al.                 | 2018  |
| Indonesian Parsing using Probabilistic Context...                    | Cahyani et al.                   | 2020  |
| The effectiveness of bottom up technique with...                     | Fairuzz Hiloh et al.             | 2018  |
| Warning and Suggestion System on Syntax Tree...                      | Haris et al.                     | 2019  |
| Title                                                                 | Author                               | Year |
|----------------------------------------------------------------------|--------------------------------------|------|
| A Finite State Machine Model to Determine Sy...                      | Haryanto and Aripin                  | 2019 |
| Tackling the Low-resource Challenge for Canon...                     | Mager et al.                         | 2020 |
| Modification of Chu-Liu/Edmonds algorithm and ...                   | Nizami and Purwarianti               | 2017 |
| Sentence boundary disambiguation for Indone...                      | Putra et al.                         | 2017 |
| Rule based sentence segmentation of Indonesian ...                  | Raharjo et al.                      | 2018 |
| Ensemble technique utilization for Indonesian de...                  | Rahman and Purwarianti              | 2017 |
| How Similar is Similar: A Comparison of Bahasa ...                 | Basuki and Antaputra                | 2020a|
| New tools for old tasks: A new approach to the ...                | Don and Knowles                     | 2020 |
| Identifying and Exploiting Definitions in Wordnet ...                | Moeljadi and Bond                   | 2016 |
| A morphophonemic analysis on the affixation in ...                 |ampa et al.                           | 2019 |
| A study of education-related Chinese words used ...                  | Kia and Su’Ad                       | 2019 |
| Learning Indonesian Frequently Used Vocabulary ...                  | Lin et al.                           | 2019b|
| Towards developing colloquial Indonesian lan...                     | Nataprawira and Carey               | 2020 |
| Pengajaran bahasa dan pemerolehan bahasa ke ...                     | Rosiyana                            | 2020 |
| An identification of authentic narrator’s name fea...                | Abd Rahman et al.                   | 2016 |
| The process of forming a more complex idiomatic ...                 | Ismail et al.                       | 2021 |
| Exploring Lexical Differences Between Indone...                     | Lin et al.                           | 2019c|
| A Corpus Driven Analysis of Representations ...                     | Nor Fariza Mohd et al.              | 2019 |
| Exploiting Malay corpus on islamic issue using ...                  | Setik et al.                        | 2018 |
| English legalese translation into Indonesian ...                   | Dewi et al.                         | 2021 |
| A corpus-based analysis of English core modal ...                   | Oktavianti                           | 2019 |
| Comparison of Personal Pronoun between Arabic ...                   | Markhamah Abdul et al.              | 2017 |
| Prosody analysis of Malay language storytelling ...                  | Ramli et al.                        | 2016 |
| Code-switching in Bruneian online retail transactions ...          | Henry and Ho                        | 2016 |
| Comparison of the themes of Malaysian Friday ...                    | Aasim Asyafi’Ie bin Ahmad et al.    | 2017 |
| Where is the Head Positioned in Indonesian Lan...                    | Ansari and Suhardijanto             | 2019 |
| Online-Dating Romance Scam in Malaysia: An ...                     | Azianura Hani et al.                | 2019 |
| Conceptual structure representation of causative ...                | Binti Yusof and Binti Rosly         | 2018 |
| A new look at Pattani Malay Initial Geminates: a ...               | Burroni et al.                      | 2020 |
| The particle pun in modern Indonesian and ...                      | Chambert-Loir                       | 2019 |
| Lagi in standard Malaysian Malay: Its meaning ...                  | Chung                                | 2019 |
| The Indonesian prefixes PE- and PEN-: A study ...                  | Denistia and Baayen                 | 2019 |
| Similar southeast asian languages: Corpus-based ...                | Ding et al.                         | 2016 |
| The Design of Lexical Database for Indonesian ...                   | Gunawan and Amalia                  | 2017 |
| Automatic extraction of multiword expression can...                 | Gunawan et al.                      | 2017b|
| The Observation of Bahasa Indonesia Official ...                   | Gunawan et al.                      | 2018a|
| Utterance-final particles in Klang Valley Malay                   | Hoogervorst                         | 2018 |
| Covid-19 dalam Korpus Peristilahan Bahasa ...                     | Kasdan et al.                      | 2020 |
| Gandaan Separa dalam Terminologi Bahasa...                         | Kasdan et al.                      | 2017 |
| Compilation of Malay criminological terms from ...               | Lee et al.                           | 2019 |
| Exploring Letter’s Differences between Partial ...                  | Lin et al.                           | 2019a|
| Hedging in the discussion sections of English and ...              | Loi and Lim                         | 2019 |
| Formation of health science terminology by users ...               | Mohamad et al.                      | 2020c|
| Politeness in communication through local chil ...                 | Mohamad Nor et al.                  | 2019 |
| Translation and Markedness                                        | Ni et al.                           | 2018 |
| Frequency of Verbs in Lifestyle Column in the ...                | Oktavianti and Pramesti             | 2019 |
| The influence of students’ L1 and spoken English ...              | Prihantoro                          | 2016 |
| Sketching the Semantic Change of Jahanam and ...                   | Puspita and Yusuf                   | 2020 |
| Vector Space Models and the usage patterns of ...                 | Rajeg et al.                        | 2019 |
| Title                                                                 | Author                          | Year |
|----------------------------------------------------------------------|---------------------------------|------|
| Cross-corpus native language identification via...                   | Rangel et al.                   | 2018 |
| Imbuhan meN- dengan Kata Nama Konkrit Unsur...                       | Saad and Jalaluddin             | 2020 |
| Ideational Grammatical Metaphors in Doctrinal...                     | Saragih et al.                  | 2017 |
| Collocation analysis of variants of intensifies in...                | Sarudin et al.                  | 2020a|
| Discourse functions of the two non-active voices...                 | Shiohara et al.                 | 2019 |
| The Framework of Multiword Expression in In...                       | Suhardijanto et al.             | 2020 |
| Acquiring Extended Units of Meaning: The Role...                     | Suhardijanto and Putra          | 2019 |
| Bila dan Mengapa ‘You’ Menjadi ‘Kita’; Satu ...                      | Sulaiman and Bin Mohamad Yusoff | 2020 |
| Frasa Topik Dan Fokus Dalam Bahasa Melayu:...                       | Sultan and Othman               | 2021 |
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| ‘Sampai Di’ Vs ‘Sampai Ke’: Accomplishment...                       | Yusof et al.                    | 2016 |
| Diachronic Corpora as a Tool for Tracing Etymo...                   | Yusuf and Puspita               | 2020 |
| Representatif Leksikal Ukuran sebagai Metafora...                    | Zaini et al.                    | 2020b|
| Designing Phonetic Alphabet for Bahasa Indone...                    | Karlina et al.                  | 2020 |
| Indonesian essay grading module using Natural...                    | Ajitiono and Widyani            | 2017 |
| Automated Bahasa Indonesia essay evaluation...                       | Amalia et al.                   | 2019a|
| Exploiting Syntactic Similarities for Preposition...                | Irmawati et al.                 | 2016 |
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| Perbandingan Deiksis pada Dua Buku Ajar: Anal...                    | Destiani et al.                 | 2018b|
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| Fossicking in dominant language teaching: Ja...                      | Maxwell-Smith                   | 2021 |
| Teaching Specific Purpose Translation: Utiliza...                   | Siiregar                        | 2017 |
| Theme markedness in the translation of student...                   | Sofyan and Tarigan              | 2018 |
| Strategi Pengukuran Upaya Berbahasa Menerusi...                    | Redzwan et al.                  | 2020 |
| Generating artificial error data for Indonesian...                   | Irmawati et al.                 | 2017b|
| Menangani Kekaburan Kemahiran Prosedur dan...                      | Anida et al.                    | 2019 |
| Environmental awareness content for character...                    | Rahmawati et al.                | 2020 |
| Development of Malay word materials for...                          | Yusof et al.                    | 2019 |
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| Trend Penggunaan Bahasa Samar dalam Persidan...                     | Tan et al.                      | 2017a|
| Form and function of negation in German and ...                    | Trionyo et al.                  | 2020 |
| Bòsò Walikan Malang’s Address Practices                           | Yannuar et al.                  | 2017 |
| Title                                                                 | Author                        | Year  |
|---------------------------------------------------------------------|-------------------------------|-------|
| Perception and metaphorical smell: A Malay                         | Zaini et al.                  | 2020a |
| House building tips (HBT) corpus dataset as a...                   | Zaini et al.                  | 2021  |
| Understanding quotation extraction and attribu...                   | Purnomo W.P et al.            | 2020  |
| An automatic health surveillance chart interpreta...                 | Aulia and Barmawi             | 2016  |
| A text representation model using Sequential...                     | Alias et al.                  | 2018b |
| Relationship analysis of keyword and chapter in...                  | Chua and Nohuddin             | 2017  |
| Relation extraction using dependency tree kernel...                 | Esperanti and Purwarianti     | 2016  |
| An experimental study of text preprocessing tech...                 | Hasanah et al.                | 2018  |
| Relation Detection for Indonesian Language Us...                    | Hasudungan and Purwarianti    | 2019  |
| Classification of short possessive clitic pronoun...                | Noor et al.                   | 2020  |
| Assessing Suitable Word Embedding Model for...                      | Phua et al.                   | 2020  |
| Experiments on coreference resolution for Indone...                 | Suherik and Purwarianti       | 2017  |
| Malay manuscripts transliteration using statistical...               | Razak et al.                  | 2019  |
| Transliteration engine for union catalogue of...                    | Razak et al.                  | 2018  |
| SMVS: A Web-based Application for Graphical...                      | Ahmat Baseri et al.           | 2020  |
| Exploring Multilingual Syntactic Sentence Repre...                  | Liu et al.                    | 2019a |
| Transfer Building of Multiword Expression Re...                     | Liu and Wang                  | 2020  |
| Reclassification of the Leipzig Corpora Collec...                   | Nomoto et al.                 | 2018a |
| Learning Indonesian-Chinese Lexicon with Bilin...                   | Qiu and Zhu                   | 2016  |
| Towards corpus and model: Hierarchical...                           | Fu et al.                     | 2021  |
| Towards a Standardized Dataset on Indonesian...                     | Khairunnisa et al.            | 2020  |
| Semi-supervised learning approach for Indone...                     | Aryoyudanta et al.            | 2017  |
| Named entity recognition for extracting concept...                  | Santoso et al.                | 2021  |
| Rule-based Approach on Extraction of Malay...                       | Zamri Abu et al.              | 2017  |
| A review of named entity recognition and classiff...                 | Mohemad et al.                | 2020a |
| Detecting proper nouns in Indonesian-language...                   | Raharjo et al.                | 2020  |
| Named entity recognition on Indonesian tweets...                    | Azarine et al.                | 2019  |
| Named entity recognition on Indonesian Twitter...                   | Rachman et al.                | 2018b |
| An enhanced Malay named entity recognition us...                    | Asmai et al.                  | 2018  |
| Named entity recognition using fuzzy c-means...                     | Salleh et al.                 | 2018  |
| Named entity recognition on Indonesian mi ...                       | Taufik et al.                 | 2017  |
| DBpedia entities expansion in automatically build...                | Alfina et al.                 | 2017  |
| Entity annotation WordPress plugin using...                         | Aprilius et al.               | 2017  |
| Developing name entity recognition for structured...                | Azzahra et al.                | 2020  |
| Detection of compound word with combination...                      | Bakar et al.                  | 2017  |
| Identification of Noun + Verb Compound Nouns...                     | Bakar et al.                  | 2018a |
| Automatic detection of compound word in Malay...                    | Bakar et al.                  | 2018b |
| Named-Entity Recognition for Indonesian Lan...                      | Gunawan et al.                | 2018c |
| A Concise Review of Named Entity Recognition...                     | Ikhwan Syafiq et al.          | 2019  |
| Empirical Evaluation of Character-Based Model...                    | Kurniawan and Louvan          | 2018  |
| A Semi-supervised Algorithm for Indonesian...                       | Leonandy et al.               | 2016  |
| Malay name entity recognition using limited re...                   | Noor et al.                   | 2016  |
| Medical Named Entity Recognition for Indone...                      | Rahman                        | 2018  |
| Pendekatan Teknik Pengecaman Entiti Nama ...                       | Saad and Mohamed Kamil        | 2018  |
| A Malay named entity recognition using condi ...                    | Salleh et al.                 | 2017  |
| Low Complexity Named-Entity Recognition for...                      | Sukardi et al.                | 2020  |
| Building Low-Resource NER Models Using Non-...                      | Tsygankova et al.             | 2021  |
| Title                                                                 | Author                        | Year  |
|----------------------------------------------------------------------|-------------------------------|-------|
| Hate speech detection in the Indonesian language:                    | Alfina et al.                  | 2018  |
| Developing Indonesian corpus of pornography                           | Andriansyah et al.            | 2018  |
| Bahasa Indonesia pre-trained word vector generator                    | Putri et al.                  | 2021  |
| Indonesian text document similarity detection system                 | Sinaga and Hansun             | 2018  |
| N-Gram Keyword Retrieval on Association Rule                         | Setiawan et al.              | 2018  |
| The Effectiveness of Using Malay Affixes for Han                       | Mohamed et al.               | 2018  |
| Author-Topic Modelling for Reviewer Assignment                        | Kusumawardani and Khairunnisa| 2019  |
| Benchmarking Mi-AR: Malay anaphora resolution                         | Xian et al.                   | 2016  |
| Fake news identification characteristics using                         | Al-Ash and Wibowo             | 2018  |
| Graph-based text representation for Malay translation                | Yulianto and Mariyah          | 2017  |
| Building automatic mind map generator for natural language            | Ruzsics and Samardzic         | 2017  |
| Classification of user comment using word2vec                        | Kurnia and Girsang            | 2021  |
| Short Message Service (SMS) Spam Filtering using                      | Theodorus et al.              | 2021  |
| Analysis and implementation of cross-lingual                         | Dewi et al.                   | 2018  |
| Long short-term memory for hate speech and abusivity                  | Salim and Suhartono           | 2021  |
| Semi-supervised learning self-training for Indonesian                | Wulan and Supangkat           | 2018  |
| Multi-Label Topic Classification of Hadith                          | Abu Bakar et al.             | 2019a |
| Hoax analyzer for Indonesian news using rnas                         | Adipradana et al.             | 2021  |
| An evolutionary-based term reduction approach                         | Alfred et al.                 | 2017  |
| Assessing factors that influence the performances                     | Alfred et al.                 | 2016  |
| A comparison study of document clustering using                       | Amalia et al.                 | 2020a |
| An Efficient Text Classification Using fastText                      | Amalia et al.                 | 2020b |
| Optimizing Deep Learning for Detection Cyber                         | Anindyati et al.              | 2019  |
| Evaluating rnn architectures for handling imbalanced data            | Christiano et al.             | 2020  |
| A comparison of supervised text classification                       | Dhammajoti et al.             | 2020  |
| Classifying Medical Document in Bahasa Indonesia                      | Dhomas Hatta and Kiki Purnama | 2021  |
| Using naive bayes classifier for application feed                     | Ferdino and Rusli             | 2019  |
| The identification of pornographic sentences in                      | Gunawan et al.                | 2019e |
| The Best Parameter Tuning on RNN Layers for                          | Hikmah et al.                 | 2020  |
| A language identifier for Indonesian and Malay                         | Indra et al.                  | 2016  |
| A category classification algorithm for Indonesian                    | Jaafar et al.                 | 2016  |
| The impacts of singular value decomposition algorithm                | Jambak et al.                 | 2019  |
| Automatic Indonesia’s questions classification                       | Kusuma et al.                 | 2016  |
| Comparative Study of Machine Learning Ap                             | Mohammad Najib et al.         | 2017  |
| Hoax Analyzer for Indonesian News Using Deep                         | Nayoga et al.                 | 2021  |
| Study of hoax news detection using naive bayes                        | Pratiwi et al.                | 2018  |
| Building a question classification model for a                        | Puteh et al.                  | 2019  |
| Age Group Based Document Classification in Bahasa                     | Putra et al.                  | 2020  |
| Hoax web detection for news in bahasa using supervised               | Rahmat et al.                 | 2019  |
| Indonesian news classification using convolution                      | Ramdhani et al.               | 2020  |
| Answer categorization method using K-means for                        | Ratna et al.                  | 2019  |
| Identifying fake news in Indonesian via supervised                    | Rusli et al.                  | 2020  |
| Indonesian news classification based on NaBaNA                       | Septian et al.                | 2017  |
| Knowing Right from Wrong: Should We Use                               | Septiandri et al.             | 2020  |
| Enhancing text classification performance by pre-                     | Setiabudi et al.              | 2021  |
| Text Classification Services Using Naïve Bayes                        | Setiani and Ce                | 2018  |
| Argument annotation and analysis using deep                           | Suhartono et al.              | 2020  |
| Semi-supervised Category-specific Review Tag                         | Sun et al.                    | 2020  |
### Table 2 (Continued)

| Title                                                                 | Author                                   | Year  |
|-----------------------------------------------------------------------|------------------------------------------|-------|
| Short Message Service Filtering with Natural Language                | Tandra et al.                            | 2021  |
| Implementation of Naïve Bayes Classifier Algorithm                    | Thirafi and Rahutomo                     | 2018  |
| Research on Pseudo-label Technology for Multi-class                    | Wang et al.                              | 2021  |
| Efficient Implementation of Dirty Words Detection                      | Yao et al.                               | 2020  |
| A Study of Text Classification for Indonesian                           | Yovellia Londo et al.                    | 2019  |
| Developing the COVID-19 Malay Corpus Using LSI Method                  | Hakimi and Rahman                        | 2021  |
| Query rewriting and corpus of semantic similarity                        | Purnamasari et al.                       | 2016  |
| Performance Evaluation of Inverted Files, B-Tree                         | Rosnan et al.                            | 2019  |
| Word prediction algorithm in resolving ambiguity                         | Sazali et al.                            | 2016  |
| Implementation of LSI method on information                            | Parwita                                  | 2020  |
| A document recommendation system of stem words                          | Pratama et al.                           | 2020  |
| Cross Language Information Retrieval Using Vector Space                 | Rahminda et al.                          | 2019  |
| Machine Learning Approach for Sentiment Analysis                       | Mantoro et al.                           | 2020  |
| Natural Language Interface to Database (NLIDB)                          | Anisyah et al.                           | 2019  |
| A Survey on Context-Aware Information Retrieval                       | Bin Rodzman et al.                      | 2018a |
| The implementation of fuzzy logic controller for text retrieval         | Bin Rodzman et al.                      | 2018b |
| Experiment with text summarization as a positive                      | Bin Rodzman et al.                      | 2019b |
| Indonesian document retrieval using vector space                        | Fitriasari et al.                        | 2017  |
| Access to Relational Databases Using Interrogation                     | Ghasani and Widagdo                      | 2018  |
| Automatic open domain information extraction                            | Gultom and Wibowo                        | 2018  |
| Open Text Ontology Mining to Improve Retrieval                         | Hamzah and Kamaruddin                    | 2021  |
| Multi-word similarity and retrieval model for a language               | Hanum et al.                             | 2019  |
| Syntactic rule-based approach for extracting concepts                   | Husin et al.                             | 2018  |
| Web Service for Search Engine Bahasa Indonesia                          | Husni et al.                             | 2020  |
| Information Retrieval for Malay Text: A Decade                         | Kamaruddin et al.                        | 2021  |
| Teknik Pengukuhan Perangkak Tumpuan melalui                           | Masnizah et al.                          | 2018  |
| Natural Language Interface to Database (NLIDB)                          | Poerta et al.                            | 2019  |
| Content-based Filtering Model for Recommendation                       | Putri et al.                             | 2019b |
| Fabricated and Shia Malay translated hadith as...                       | Rodzman et al.                           | 2020  |
| Domain specific concept ontologies and text summarization               | Rodzman et al.                           | 2019  |
| Rule-based Indonesian Open Information Extraction                      | Romadhony et al.                        | 2018  |
| A Statistical Linguistic Terms Interrelationship                        | Yusuf et al.                             | 2021  |
| A Survey: Framework of an Information Retrieval                         | Zulkifli et al.                          | 2017  |
| Crowdsourcing in developing repository of phrase                         | Thamrin et al.                           | 2019a |
| Single document keywords extraction in Bahasa Indonesia                 | Trisna and Nurwidyantoro                 | 2020  |
| Topic modeling on Indonesian online shop chat                           | Hidayatullah et al.                      | 2019  |
| Indonesian abstractive text summarization using machine learning        | Adelia et al.                            | 2019  |
| Topic labeling towards news document collection                         | Adhitama et al.                          | 2017  |
| MYTextSum: A Malay Text Summarizer Model                                | Alias et al.                             | 2018a |
| A Malay text corpus analysis for sentence compression                    | Alias et al.                             | 2016  |
| Extract, compress and summarize–An experiment                         | Alias et al.                             | 2017c |
| A Malay text summarizer using pattern-growth                            | Alias et al.                             | 2017b |
| Understanding Human Sentence Compression Pattern                        | Alias et al.                             | 2018c |
| Bilingual extractive text summarization model                          | Alias et al.                             | 2020  |
| A Syntactic-based Sentence Validation Technique                         | Alias et al.                             | 2021  |
| Indonesian Automatic Text Summarization Based                           | Cai et al.                               | 2019  |
| Summarizing Indonesian news articles using a...                         | Garmastewira and Khodra                  | 2019  |
| Review of the recent research on automatic text summarization           | Gunawan and Amalia                       | 2018  |

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*Note: The table continues with more entries.*
| Title                                                                 | Author                      | Year   |
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| Multi-document Summarization by using Tex                        | Gunawan et al.             | 2019b  |
| Automatic Text Summarization for Indonesian                         | Gunawan et al.             | 2017a  |
| Liputan6: A Large-scale Indonesian Dataset for                       | Koto et al.                | 2020a  |
| Peringkasan dokumen berita Bahasa Indonesia                        | Mandar and Gunawan          | 2017   |
| The purpose of bellman-ford algorithm to summarization              | Maylawati et al.           | 2020   |
| Sequential pattern mining and deep learning to summarization         | Maylawati et al.           | 2019   |
| Technique on Malay text summarization: A review                      | Mohemad et al.             | 2020b  |
| Generation of news headline for Malay language                      | Noah et al.                | 2018   |
| Text simplification for Malay corpus: A Review                       | Omar et al.                | 2021   |
| Automatic Text Summarization for Malay News                         | Rahman et al.              | 2021b  |
| Towards product attributes extraction in Indonesian                  | Rif’at et al.              | 2018   |
| Multidocument Abstractive Summarization using Pre...                | Severina and Khodra         | 2019   |
| Penjanaan Ringkasan Isi Utama Berita Bahasa                          | Shahrul Azman Mohd et al.  | 2018b  |
| Terrorism domain corpus building using Latent                         | Suhendra et al.            | 2018   |
| Topic Modelling for Malay News Aggregator                           | Weiying et al.             | 2018   |
| A comparative review of extractive text summarization                | Widodo et al.              | 2021   |
| Indonesian Abstractive Summarization using Pre...                   | Wijayanti et al.           | 2021   |
| A Conceptual Framework for Malay-English                             | Lim et al.                 | 2021   |
| Design of Ontology-based Question Answering                         | Yunmar and Wayan Wiprayoga Wisesa | 2019 |
| Corpus development for Indonesian consumer                           | Hakim et al.               | 2018   |
| Towards question identification from online                          | Mahendra et al.            | 2018a  |
| WPS: Application for Generating Answer of...                        | Oktavia et al.             | 2021   |
| Automated question generating method based on...                     | Wijanarko et al.           | 2020   |
| Question generation model based on key-phrase...                     | Wijanarko et al.           | 2021   |
| Developing Question Generation System for Ba...                      | Wisnu Prabowo et al.       | 2021   |
| Developing an adaptive language model for Ba...                      | Hidayatullah and Suyanto    | 2019   |
| Pembangunan Taksonomi dari Teks Melayu...                            | Mohd Zakree Ahmad et al.   | 2018   |
| Document Similarity Detection Using Indonesian...                    | Ramadharti and Mariyah     | 2019   |
| Paraphrase construction of Al Quran in Indone...                     | Hutami et al.              | 2019   |
| Rude-Words Detection for Indonesian Speech Us...                     | Novitasari et al.          | 2019   |
| Taxonomy development from Malay text using...                        | Ahmad Nazri et al.         | 2018   |
| Cross-Language Plagiarism Detection System Us...                    | Anak Agung Putri et al.    | 2017   |
| Plagiarism Detection for Indonesian Language...                      | Arifin et al.              | 2018   |
| Knowledge representation system for copula sen...                    | Cahyani et al.             | 2016   |
| Keyword extraction from scientific articles in Ba...                 | Gunawan et al.             | 2020   |
| Extracting disease-symptom relationships from...                    | Halim et al.               | 2018   |
| Segregation of Code-Switching Sentences using...                    | Kasmuri and Basiron        | 2020   |
| Automated verbalization of ORM models in...                         | Lim and Halpin             | 2016   |
| Noun phrases extraction using shallow parsing...                    | Santoso et al.             | 2016   |
| Implementing Graph Based Rank on Online News...                      | Syafiandini et al.         | 2019   |

| Title                                                                 | Author                      | Year   |
|----------------------------------------------------------------------|-----------------------------|--------|
| A framework for English and Malay cross-lingual...                  | Nasharuddin et al.          | 2019   |
| User participation in building language reposi...                    | Thamrin et al.              | 2018   |
| Google vs. Instagram Machine Translation: Mul...                     | Larassati et al.            | 2019   |
| Neural Machine Translation model for University...                   | Aneja et al.                | 2020   |
| Quality translation enhancement using sequence...                    | Ayu et al.                  | 2018   |
| Meaning preservation in Example-based Machine...                     | Chua et al.                 | 2017   |
| English-Indonesian Neural Machine Translation...                     | Dwiastuti                    | 2019   |

| Title                                                                 | Author                      | Year   |
|----------------------------------------------------------------------|-----------------------------|--------|
| Translation                                                          |                             |        |

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### Title |
| Author |
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| Benchmarking multidomain English-Indonesian translation... | Guntara et al. | 2020 |
| A Neural Machine Translation Approach for... | Low et al. | 2020 |
| IIT Bombay’s English-Indonesian submission at... | Singh et al. | 2016 |
| Source language adaptation approaches for... | Wang et al. | 2016 |
| Hybrid machine translation with multi-source... | Yeong et al. | 2018 |
| Using Dictionary and Lemmatizer to Improve... | Yeong et al. | 2016 |
| Semi-Supervised Low-Resource Style Transfer... | Wibowo et al. | 2020 |
| Morphological analysis of speech translation into... | Nurilman Baehaqi et al. | 2019 |
| Pengaruh Pennambahan Korpus Paralel pada... | Abidin and Permata | 2021 |
| Effect of mono corpus quantity on statistical ma... | Abidin et al. | 2021 |
| Peningkatan Mesin Penerjemah Statistik dengan... | Darwis et al. | 2019 |
| Peningkatan Akurasi Penerjemah Bahasa Daerah... | Sujaini | 2018 |
| Translation Learning Tool for Local Language to... | Warnars et al. | 2021 |
| Leveraging additional resources for improving... | Trieu et al. | 2019 |
| Rule-based Reordering and Post-Processing for... | Mawalim et al. | 2017 |
| A novel Hadith authentication mobile system in... | Fadele et al. | 2020 |
| Translation of idioms from Arabic into Malay via... | Abidin et al. | 2020 |
| Multiple pivots in statistical machine translation... | Budiwati and Aritsugi | 2019 |
| A Parallel Evaluation Data Set of Software Docu... | Buschbeck and Exel | 2020 |
| A Comprehensive Analysis of Bilingual Lexicon... | Irvine and Callison-Burch | 2017 |
| Malay-corpus-enhanced Indonesian-Chinese neu... | Liu and Wang | 2019 |
| Language Resource Extension for Indonesian-... | Liu et al. | 2019b |
| Development of mobile application for Malay... | Rahman et al. | 2020 |
| Enhancing Pivot Translation Using Grammatical... | Trieu and Nguyen | 2018 |
| Translating Malay Compounds into Arabic Based... | Wahiyudin and Romli | 2021 |
| Generating image description on Indonesian lan... | Nugraha et al. | 2019 |
| Visual question answering for monas tourism ob... | Siregar and Chahyati | 2020 |
| Learning translations via images with a massively... | Hewitt et al. | 2018 |
| Adaptive Attention Generation for Indonesian Im... | Mahadi et al. | 2020 |
| Cross-lingual projection for class-based language... | Gfeller et al. | 2016 |
| Extremely Low-Resource Neural Machine Trans... | Rubino et al. | 2020 |
| Machine translation of Indonesian: A review... | Septarina et al. | 2019 |

**See also** - A review on Indonesian machine trans... Rahutomo et al. 2019

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| Author |
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| Malay speech corpus of telecommunication call... | Draman et al. | 2017 |
| Detection of Malay phrase breaks using energy... | Mohamed Hanum and Abu Bakar | 2016 |
| A hybrid approach for single channel speech en... | Jamal et al. | 2020 |
| Developing ASR for Indonesian-English Bilin... | Maxwell-Smith and Foley | 2021 |
| Applications of natural language processing in... | Maxwell-Smith et al. | 2020 |
| Robust Feature Extraction Based On Spectral And... | Ibrahim et al. | 2019 |
| Transfer learning with bottleneck feature net... | Lim et al. | 2016 |
| Cross-Lingual Machine Speech Chain for Ja... | Novitasari et al. | 2020 |
| Comparing statistical classifiers for emotion clas... | Hamzah et al. | 2017 |
| Influences of age in emotion recognition of spon... | Jamil et al. | 2017 |
| Influences of languages in speech emotion recog... | Rajoo and Aun | 2016 |
| Voice-Based Malay Commands Recognition by... | Abu et al. | 2020 |
| Automatic Transcription and Captioning System... | Andrea and Usagawa | 2020 |
| Improved Transcription and Speaker Identifica... | Andrea and Usagawa | 2021 |
| Title                                                                 | Author                                      | Year   |
|----------------------------------------------------------------------|---------------------------------------------|--------|
| Speech-to-Text Conversion in Indonesian Language                      | Dwijayanti et al.                           | 2021   |
| Comparison of feature extraction MFCC and LPC                        | Endah et al.                                | 2017   |
| Development of language identification system                         | Gunawan et al.                              | 2018b  |
| Voiced and unvoiced separation in Malay speech                       | Hanifa et al.                               | 2019   |
| Wavelet based feature extraction for the vowel sound                  | Hidayat et al.                              | 2016   |
| Shared-hidden-layer deep neural network for                           | Hoesen et al.                               | 2018   |
| Classification and clustering to identify spoken                      | Ibrahim and Lestari                         | 2018   |
| Automatic phoneme identification for Malay dialects                   | Khaw et al.                                 | 2017   |
| Speech to Text of Patient Complaints for Bahasa                       | Laksono et al.                              | 2019   |
| Malay language speech recognition for preschool                       | Maseri and Mamat                            | 2019   |
| Indonesian audio-visual speech corpus for multi                       | Maulana and Fanany                         | 2018a  |
| Sentence-level Indonesian lip reading with spa                        | Maulana and Fanany                         | 2018b  |
| Sphinx4 for Indonesian continuous speech recog                        | Muljono et al.                              | 2017b  |
| Indonesian graphemic syllabification using a near                      | Parande and Suyanto                         | 2019   |
| Rule-Based Pronunciation Models to Handle                             | Putri et al.                                | 2019a  |
| Speech to Text Translation for Malay Language                         | Rami Ali and Rini                           | 2017   |
| Assessing automatic speech recognition in mea                        | Rosdi et al.                                | 2017   |
| Hybrid methods of Brandt’s generalised likely                        | Seman and Norazam                           | 2019   |
| Incorporating syllabification points into a model                     | Suyanto                                     | 2019b  |
| Flipping onsets to enhance syllabification                           | Suyanto                                     | 2019a  |
| Phonological similarity-based backoff smoothing                       | Suyanto                                     | 2020   |
| End-to-End Speech Recognition Models for a                           | Suyanto et al.                              | 2020   |
| Indonesian syllabification using a pseudo nearest                     | Suyanto et al.                              | 2016   |
| Recognizing Five Major Dialects in Indonesia                         | Tawaqal and Suyanto                         | 2021   |
| Specific acoustic models for spontaneous and dic                      | Vista et al.                                | 2018   |
| Cloud-based automatic speech recognition sys                         | Wang et al.                                 | 2018   |
| Smart presentation system using hand gestures                         | Wardhany et al.                             | 2016   |
| Leveraging Text Data Using Hybrid Transformer                        | Zeng et al.                                 | 2021   |
| Indonesian Corpus Constructing and Text Process                      | Kong and Yang                               | 2018   |
| Utilizing Indonesian Allophones and Intraword                         | Uliniansyah et al.                          | 2019   |
| Developing an online self-learning system of In                       | Muljono et al.                              | 2016   |
| Automatic Pronunciation Generator for Indone                         | Hoesen et al.                               | 2019   |
| Multi Speaker Speech Synthesis System for In                         | Budiman and Lestari                         | 2020   |
| A Bilingual Speech Synthesis System of Standard                      | Chen et al.                                 | 2020   |
| Poetry visualization in digital technology                            | Noh et al.                                  | 2019   |
| The first Malay language storytelling text-to-                        | Ramli et al.                                | 2017   |
| An Iterated Two-Step Sinusoidal Pitch Contour                        | Ramli et al.                                | 2021   |
| A Tool to Solve Sentence Segmentation Problem                        | Uliniansyah et al.                          | 2016   |
| Enhancing Prosodic Features by Adopting Pre                          | Zhao et al.                                 | 2020   |
| Anita: Intelligent Humanoid Robot with Self-                          | Andreas et al.                              | 2019   |
| A novel model and implementation of humanoid                         | Budiarto et al.                             | 2021   |
| Teach your robot your language! trainable neural                      | Hinaut and Twiefel                          | 2020   |
| The Architecture of Speech-to-Speech Translator                      | Santosa et al.                              | 2019   |
| Development of text and speech corpus for an                         | Teduh Uliniansyah et al.                    | 2018   |
| Chatbot Application on Internet of Things (IoT)                       | Gunawan et al.                              | 2019f  |
| Virtual assistant using lstm networks in Indonesian                  | Mirwan et al.                               | 2018   |
| Forming of Dyadic Conversation Dataset for Ba                         | Tho et al.                                  | 2018   |
| Development of Indonesian Language Speech                             | Yossy et al.                                | 2020   |
| GMM based automatic speaker verification sys                         | Stefanus et al.                             | 2017   |
### Continuation of Table 2

| Title                                                                 | Author                             | Year  |
|----------------------------------------------------------------------|------------------------------------|-------|
| Recurrent Neural Network to Deep Learn Conver . . .                   | Chowanda and Chowanda              | 2017  |
| Virtual phone discovery for speech synthesis with . . .              | Nayak et al.                       | 2019  |

### Speaker States

| Title                                                                 | Author                             | Year  |
|----------------------------------------------------------------------|------------------------------------|-------|
| An automatic lexicon generation for Indonesian . . .                  | Ayu et al.                         | 2019  |
| Minimally-supervised sentiment lexicon induc . . .                     | Darwich et al.                     | 2017  |
| Extraction Sentiment Analysis Using naive Bayes . . .                  | Jaka Harjanta and Herlambang      | 2020  |
| Automatic Semantic Orientation of Adjectives for . . .                 | Riyanti et al.                     | 2018  |
| Enhanced Malay sentiment analysis with an en . . .                     | Al-Moslmi et al.                   | 2017  |
| Aspect and Opinion Extraction of Indonesian Lip . . .                 | Kun Indarta and Romadhony         | 2021  |
| Identifying deception in Indonesian transcribed . . .                  | Warnita and Lestari                | 2017  |
| Aspect Extraction for Tourist Spot Review in In . . .                  | Yanuar and Shiramatsu              | 2020  |
| Framework of sentiment annotation for document . . .                  | Sutabri and Ardiyangsyah           | 2017  |
| Evaluation of support vector machine and deci . . .                    | Saad et al.                        | 2018a |
| Sentiment analysis for low resource languages: A . . .                 | Le et al.                          | 2016  |
| Indonesian Lexicon-Based Sentiment Analysis of . . .                   | Kurniawan et al.                   | 2021  |
| A Simplified Method to Identify the Sarcastic Ele . . .                | Wijaya et al.                      | 2020  |
| Experiment with lexicon based techniques on . . .                     | Bin Rodzman et al.                 | 2019a |
| Implementation of a Machine Learning Algo . . .                       | Buntoro et al.                     | 2021  |
| Sentiment Analysis of Malay Social Media Text                          | Chekima and Alfred                | 2018  |
| Random forest approach fo sentiment analysis in . . .                  | Fauzi                             | 2018  |
| Word embedding comparison for Indonesian lan . . .                     | Imaduddin et al.                   | 2019  |
| Text Mining and Support Vector Machine for Sen . . .                   | Imamah et al.                     | 2020  |
| Unsupervised aspect-based sentiment analysis on . . .                  | Sasmita et al.                     | 2018  |
| Elman recurrent neural network for aspect based . . .                  | Widiastuti and Ali                 | 2021  |
| Multilingual sentiment analysis: A systematic lit . . .                | Abdullah and Rusli                 | 2021  |
| Polarity classification tool for sentiment analysis . . .              | Abu Bakar et al.                   | 2019b |
| Long short term memory convolutional neural . . .                     | Af’idah et al.                     | 2020  |
| Malay sentiment analysis based on combined clas . . .                  | Al-Saffar et al.                   | 2018  |
| An analysis of Malay language emotional speech . . .                   | Apandi and Jamil                   | 2017  |
| Aspect-Based Sentiment Analysis Using Convo . . .                      | Cakyadi and Khodra                 | 2018  |
| Rule-Based Model for Malay Text Sentiment . . .                       | Chekima et al.                     | 2018  |
| Speech-Emotion Detection in an Indonesian Movie                        | Fahmi et al.                      | 2020  |
| A comparative study of sentiment analysis using . . .                  | Fikri and Sarno                    | 2019  |
| Sentiment analysis for Malay language: system . . .                    | Handayani et al.                   | 2018  |
| Sentiment analysis using recurrent neural . . .                       | Kurniasari and Setyanto            | 2020a |
| Sentiment analysis using Recurrent Neural Network . . .                | Kurniasari and Setyanto            | 2020b |
| Aspect-based Opinion Mining on Beauty Product . . .                    | Mahfiz and Romadhony               | 2020  |
| Aspect-Based Sentiment Analysis on Candidate . . .                     | Manik et al.                      | 2020  |
| Sentiment Analysis Using Word2vec and Long . . .                      | Muhammad et al.                    | 2021  |
| English and Malay cross-lingual sentiment lex . . .                    | Nasharuddin et al.                 | 2017  |
| Word2vec for Indonesian sentiment analysis to . . .                    | Nawangsari et al.                  | 2019  |
| The Influence of Negation Handling on Sentiment . . .                  | Ningtyas and Herwanto              | 2018  |
| Sentiment analysis system for movie review in . . .                    | Nurdiansyah et al.                 | 2018  |
| An experimental study of lexicon-based sentiment . . .                 | Pamungkas and Putri                | 2017  |
| A comparison of the use of several different re . . .                  | Pratama et al.                     | 2019  |
| Pair Extraction of Aspect and Implicit Opinion . . .                   | Setiowati et al.                   | 2019  |
| Sentiment analysis of application user feedback . . .                  | Wiratama and Rusli                 | 2019  |
| Sentiment analysis of economic news in Bahasa . . .                    | Zamahsyari and Nurwidyantoro      | 2017  |
| Title                                                                 | Author                                                      | Year |
|----------------------------------------------------------------------|-------------------------------------------------------------|------|
| Indonesia Hate Speech Detection Using Deep                            | Sutejo and Lestari                                          | 2019 |
| Criminality recognition using machine learning                        | Malim et al.                                                | 2019 |
| Personality Measurement Design for Ontology                           | Alamsyah et al.                                             | 2020 |
| A preliminary study on hybrid sentiment model                         | Eshak et al.                                                | 2018 |
| A Progress on the Personality Measurement                             | Alamsyah et al.                                             | 2019 |
| Speech Emotion Recognition for Indonesian Lan                         | Lasiman and Lestari                                         | 2019 |

| Title                                                                 | Author                                                      | Year |
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| Opinion QA-Pairs Generation from Indonesian                          | Suwaringsih and Nuryani                                     | 2019 |
| Preprocessing for crawler of short message social                    | Ariestya et al.                                             | 2018 |
| Pola Penggunaan Bahasa Melayu dalam Twitter                           | Khalid and Rahim                                            | 2021 |
| Cyberbullying through intellect-related insults                        | Sood et al.                                                 | 2020 |
| Formal and Non-Formal Indonesian Word Usage                           | Utami et al.                                                | 2019b|
| Ten-year compilation of #savekpk Twitter dataset                     | Rahutomo et al.                                             | 2020 |
| Word Cloud Result of Mobile Payment User Re                           | Dewi et al.                                                 | 2020 |
| Ensemble method for Indonesian Twitter hate                            | Fauzi and Yuniarti                                          | 2018 |
| Event detection in Twitter: A keyword volume                          | Hossny and Mitchell                                         | 2019 |
| Multi-label Hate Speech and Abusive Language                          | Ibroidhim and Budi                                          | 2019a|
| Identification of hate speech and abusive language                    | Ibroidhim et al.                                            | 2019 |
| Classification of Radicalism Content from Twitter                     | Idris et al.                                                | 2019 |
| Hierarchical multi-label classification to identify                   | Prabowo et al.                                              | 2019 |
| Topic classification and clustering on Indonesian                      | Pratama and Purwarianti                                      | 2017 |
| Twitter Topic Modeling on Football News                               | Hidayatullah et al.                                         | 2018 |
| Topic Summarization of Microblog Document in...                      | Jiwanggi and Adriani                                        | 2016 |
| Negation handling in sentiment classification us                       | Amalia et al.                                               | 2018 |
| A Framework for Sentiment Analysis Implement                          | Asniar and Aditya                                           | 2017 |
| Social Media Analytics using Sentiment and Con                         | Balakrishnan et al.                                         | 2021 |
| Multi-Classes Emotion Detection for Unbalanced                         | Farsiah et al.                                              | 2020 |
| Twitter sentiment analysis in under-resourced lan                     | Ferdiana et al.                                             | 2019 |
| Corpus Usage for Sentiment Analysis of a Hash                         | Herlawati et al.                                            | 2019 |
| Sentiment analysis on Bahasa Indonesia tweets                         | Iswanto and Poerwoto                                        | 2018 |
| Social tension and crime related events detection                      | Jamil et al.                                                | 2019 |
| Bilingual sentiment detection - Investigating im                      | Kaur and Balakrishnan                                       | 2016 |
| Comparison of SVM Naive Bayes Algorithm for                           | Kristiyaniti et al.                                         | 2019 |
| Indonesian Twitter Sentiment Analysis Using                           | Kurniawan and Maharani                                      | 2020 |
| Aspect-level Sentiment Analysis for Social Media                      | Kusumawardani and Maulidani                                 | 2020 |
| Sentiment Analysis Using Weighted Emoticons                           | Maulidiah Elfajr and Sarno                                  | 2018 |
| Employ Twitter data to perform sentiment analy                        | Mohamad et al.                                              | 2020b|
| Classification of Twitter data by sentiment analy                      | Mohamad et al.                                              | 2020a|
| Detecting candidates of depression, anxiety and...                   | Nasrudin et al.                                             | 2019 |
| Naive Bayes as opinion classifier to evaluate stu                     | Permana et al.                                              | 2017 |
| Sentiment Analysis of BPJS Kesehatan’s Services                       | Rasyada et al.                                              | 2020 |
| When Homecoming is not Coming: 2021 Home                             | Sandra and Lumbangaol                                       | 2021 |
| Aspect-Based Sentiment Analysis for Posts on                           | Setik et al.                                                | 2021 |
| Applying Opinion Mining Technique on Tourism                          | Situmorang et al.                                           | 2019 |
| Does it make you sad? A lexicon-based sentiment analy                 | Suryadi                                                      | 2021 |
| Emotion analysis using self-training on...                            | Tan et al.                                                  | 2020 |
| Sentiment analysis for telco popularity on Twitter                    | Tan et al.                                                  | 2016 |
| Hate speech classification in Indonesian language                      | Taradhita and Putra                                         | 2021 |
| Title                                                                 | Author                                         | Year  |
|----------------------------------------------------------------------|-----------------------------------------------|-------|
| Continuation of Table 2                                              |                                               |       |
| Sentiment Analysis of Indonesians Response to...                     | Tauhid and Ruldeviyani                        | 2020  |
| Code-mixed sentiment analysis of Indonesian lan...                   | Tho et al.                                    | 2021  |
| Simulation of marketplace customer satisfaction...                   | Turdjai and Mutijarsa                         | 2017  |
| Hashtag Global Surgery: The Role of Social Me...                    | Vervoort and Luc                              | 2020  |
| School from home situation in Indonesia: An ex...                    | Wahyuni et al.                                | 2020  |
| Measuring happiness in large population                             | Wenas et al.                                  | 2016  |
| Sentiment analysis of informal Malay tweets with...                 | Ying et al.                                   | 2020  |
| Developing cross-lingual sentiment analysis of...                   | Zabha et al.                                  | 2019  |
| Automatic Labelling of Malay Cyberbullying ...                      | Maskat et al.                                 | 2020  |
| Personality prediction based on Twitter informa...                  | Ong et al.                                    | 2017  |
| Personality Modelling of Indonesian Twitter...                      | Ong et al.                                    | 2021  |
| Profiling analysis of DISC personality traits based ...             | Utami et al.                                  | 2019a |
| Supervised learning and resampling techniques...                    | Utami et al.                                  | 2021  |
| D-Loc Apps: A Location Detection Application...                     | Fitrianah et al.                              | 2020  |
| Music interest classification of Twitter users us ...               | Yusra et al.                                  | 2017  |
| Lexical based sentiment analysis - Verb, adverb ...                 | Shamsudin et al.                              | 2016  |
| Construction of the Malay language psychometric ...                 | Ahmad et al.                                  | 2017  |
| Hate speech detection in Indonesian language on ...                 | Bunga Batara et al.                           | 2019  |
| Hate speech detection in Indonesian language on ...                 | Erizal et al.                                 | 2019  |
| Hate speech detection on Indonesian Instagram...                     | Pratiwi et al.                                | 2019  |
| Hate speech detection in Indonesian language In ...                 | Putra and Nurjanah                            | 2020  |
| Hate speech detection in Indonesian language on ...                 | Briliani et al.                               | 2019  |
| Recognizing the sarcastic statement on WhatsApp ...                 | Afiyati et al.                                | 2018  |
| Construction of Malay abbreviation corpus based ...                 | Omar et al.                                   | 2017  |
| Context-sensitive normalization of social media...                  | Kusumawardani et al.                          | 2018  |
| A taxonomy of Malay social media text                               | Maskat and Munarko                            | 2019  |
| Detecting opinion spams through supervised ...                      | Hazim et al.                                  | 2018  |
| The development of Bahasa Indonesia corpora for ...                 | Jambak and Setiawan                           | 2018  |
| Review on sentiment analysis approaches for so ...                  | Abdullah et al.                               | 2017  |
| Sentiment Analysis of Noisy Malay Text: State ...                   | Abu Bakar et al.                              | 2020  |
| Emotion detection of tweets in Indonesian lan ...                   | Cahyaningtyas et al.                          | 2017  |
| Bias aware lexicon-based Sentiment Analysis of ...                 | Hijazi et al.                                 | 2017  |
| Translated vs non-translated method for multilin ...                | Ibrohim and Budi                              | 2019b |
| Classification and quantification of user’s emo ...                 | Jamaluddin et al.                             | 2017  |
| A hybrid model for social media sentiment analy...                   | Putra et al.                                  | 2018b |
| Natural language processing based features for ...                  | Suhaimin et al.                               | 2017  |
| Modified framework for sarcasm detection and ...                    | Suhaimin et al.                               | 2019  |
| Concerns of thalassemia patients, carriers, and ...                | Phang et al.                                  | 2021  |
| End of Table                                                        |                                               |       |