# Influence of Contextual Information on Bengali-English Forward and Backward Transliteration Using Binary Coding

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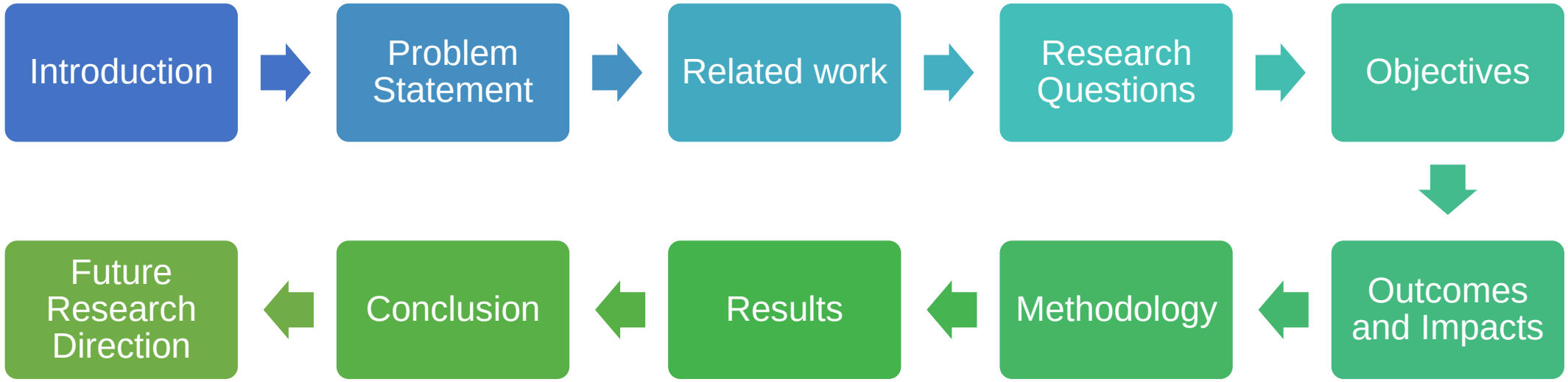
# Outline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# Introduction

Transliteration

- Converts the written form of a language
- From one language to another
- Retains phonetic meaning

Table 1: Bengali to English transliteration

| Original | Transliterated |
|---|---|
| শিক্ষাবিদ | shikkhabid |
| বাংলা | bangla |
| ভাষা | bhasha |
| আমার | amar |

# Related Work

Table 2: Literature review

| AUTHOR | CONTRIBUTION | LIMITATION | DIFFERENCE |
|---|---|---|---|
| Ekbal et al. [1] | 6 n-gram based probabilistic models | Only used 6000 NEs, private dataset | Evaluated on common words, provides algorithm for TU identification |
| Sarkar and Chatterjee [2] | One-hot coding for representing TU, used traditional ML model SVM and KNN | Evaluated on only 1000 NEs, private dataset | Our study uses binary coding in place of one hot coding for the TUs, uses 6 contextual models |
| Dasgupta et al. [3] | Joint source channel model, SMT model | Backward transliteration approach | Both forward and backward transliteration, TU identification algorithm |
| Tipu et al. [4] | Binary coding for TU representation, evalua ted with process time | Only one feature representation, and no backward transliteration | This study uses 6 contextual models and evaluates both forward and backward transliteration |

# Problem Statement

- Limited publicly available datasets
- Lack of standardization for Bengali language
- Insufficient research using grapheme-level context

# Research Questions

How do contextual feature selection techniques affect transliteration outcomes?

How to increase transliteration accuracy?

# Objectives

- Automate TU decomposition step
- Explore the impact of contextual feature selection
- Investigate transliteration using a grapheme-based approach

# Outcomes and Impacts

**Expected outcome:**

- Correct transliteration

**Possible impacts:**

- Automatic and reliable system
- Unhindered cross-lingual communication

# Methodology

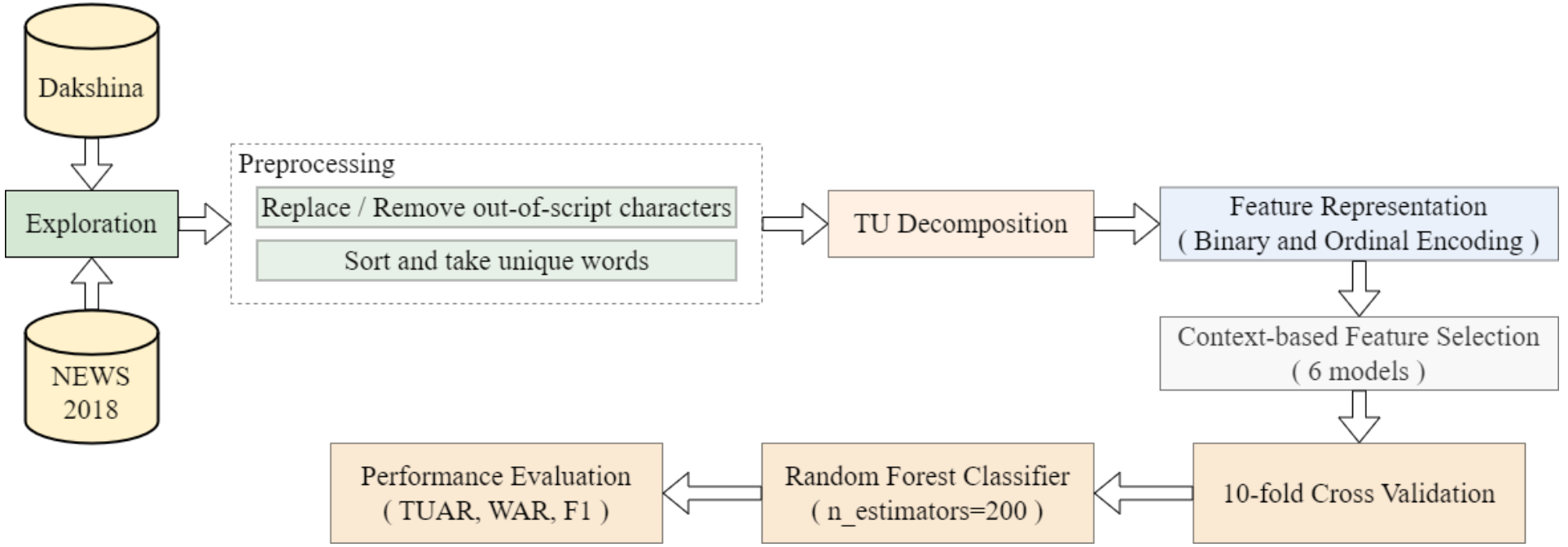


Figure 1: Proposed Methodology

# Methodology

- Types of words in dataset
  - Dakshina [5]: Dictionary, NE, Technical
  - NEWS 2018 [6]: NE
- **Invalid words**: Words containing null/empty, punctuations, numbers, out-of-script characters
- Sort and take unique Bengali words

Table 3: Dataset Statistics

| Criteria | Dakshina | NEWS 2018 |
|---|---|---|
| Total Words | 130378 | 13623 |
| Valid Words | 113873 | 13614 |
| Unique Words ( Bengali, English ) | ( 25395, 25395 ) | ( 13312, 13312 ) |

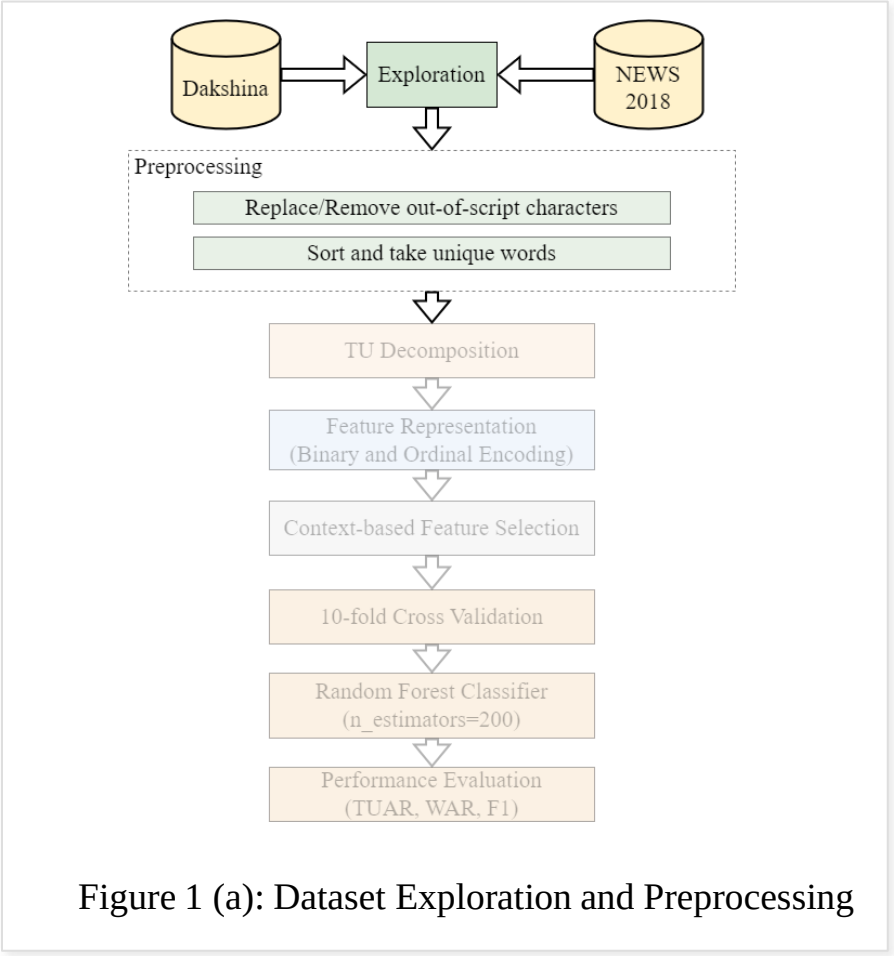


Figure 1 (a): Dataset Exploration and Preprocessing

# Methodology

- Transliteration Unit (TU) decompose:
  - আমার → [ আ | মা | র ]
  - amar → [ a | ma | r ]

Table 4: TU Statistics

| Criteria | Dakshina | NEWS 2018 |
|---|---|---|
| TU aligned Words | 15431 | 7535 |
| Average number of TU per word | 3.473 | 3.249 |
| Maximum number of TU per word | 9 | 8 |
| Minimum number of TU per word | 1 | 1 |
| Number of unique TUs ( Bengali, English ) | ( 1401, 1616 ) | ( 927, 1163 ) |

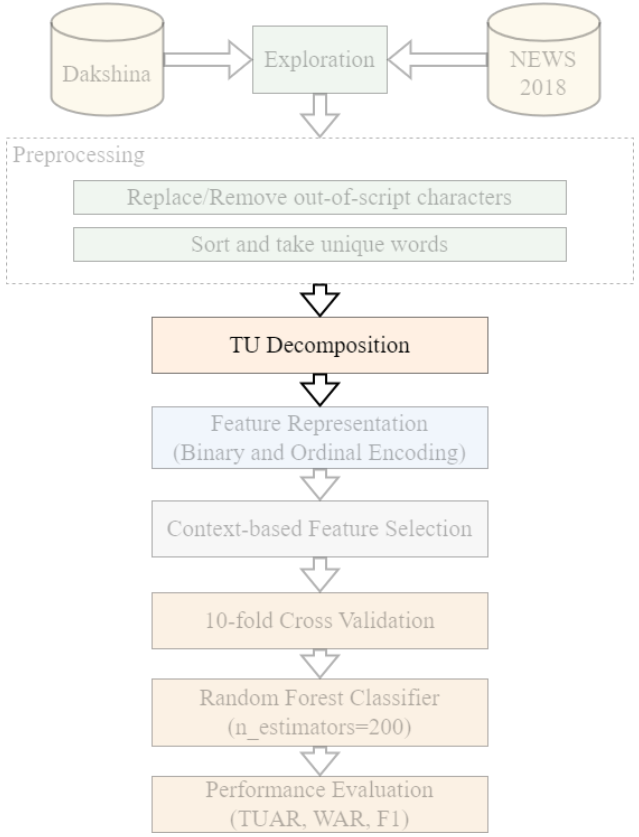


Figure 1 (b): TU decomposition

# Methodology

- Encode: converts string to numerical form

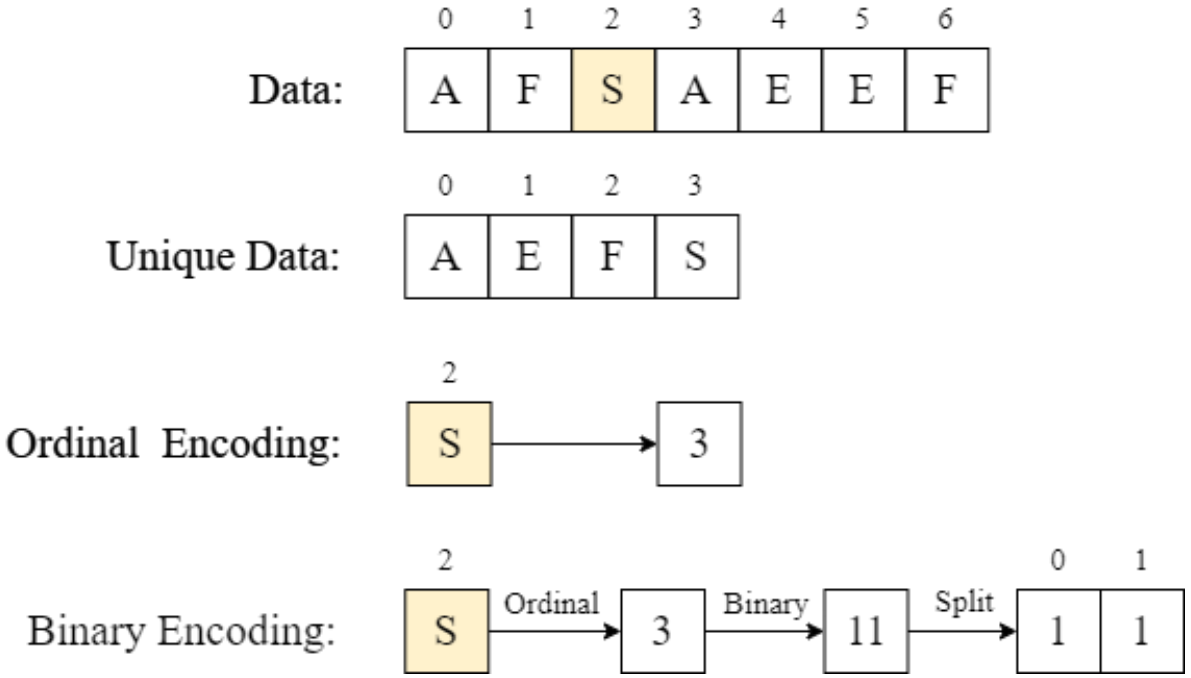


Figure 2: Encoding

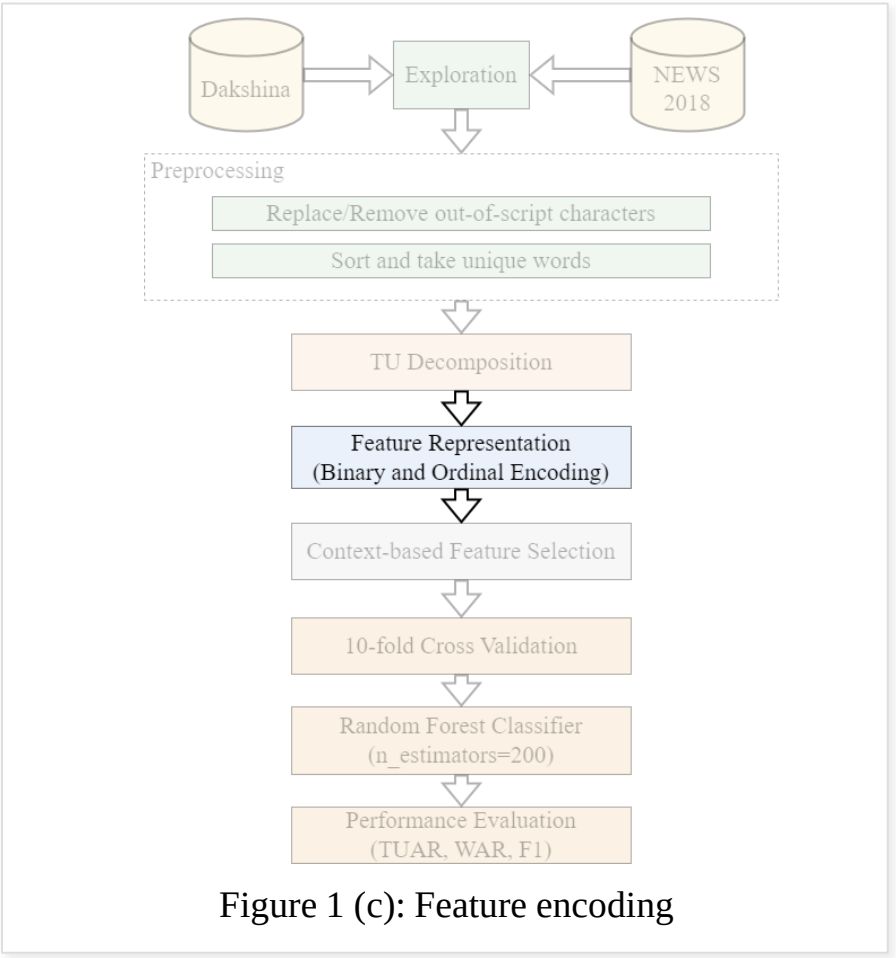


Figure 1 (c): Feature encoding

# Methodology

- Context
  - n-gram based
  - Preceding and/or succeeding STU
  - Preceding target TU (TTU)
- Feature selection
  - Model A (monogram, context-free)
  - Model B (Preceding STU)
  - Model C (succeeding STU)
  - Model D (preceding STU, TTU)
  - Model E (neighboring STU))
  - Model F (neighboring STU, TTU)

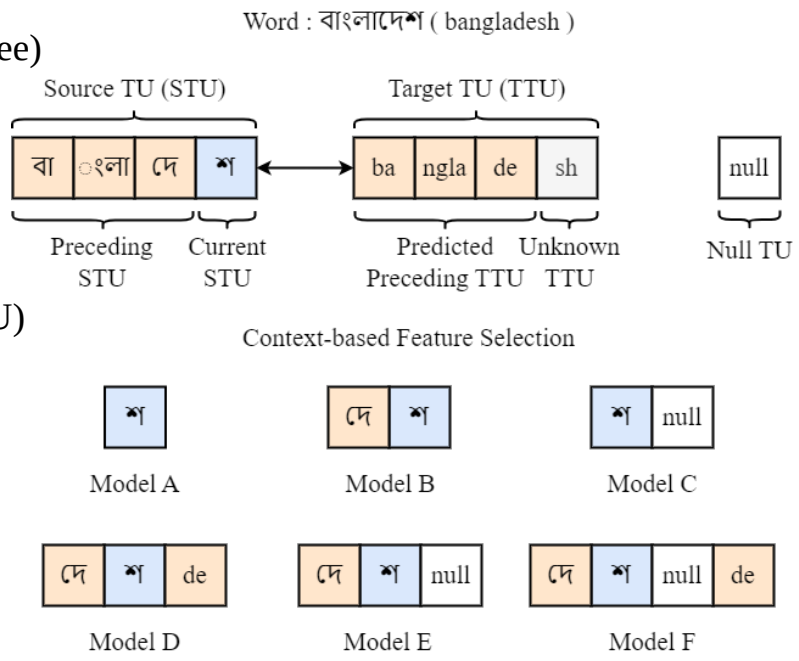


Figure 3: Context-based Feature Selection

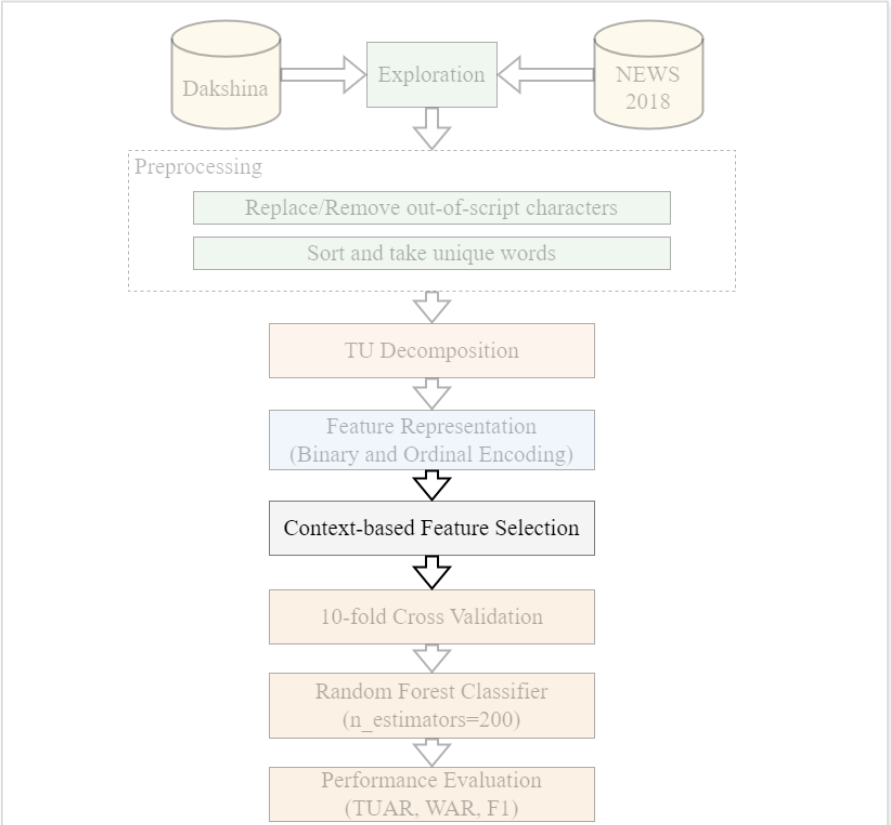


Figure 1 (d): Feature selection

# Methodology

- Machine learning model

**Random Forest Classifier**

- n_estimators = 200

- Performance Metrics

**Accuracy**

**F1 score**

TU level accuracy ( TUAR )

Word level accuracy ( WAR / Top-1 )

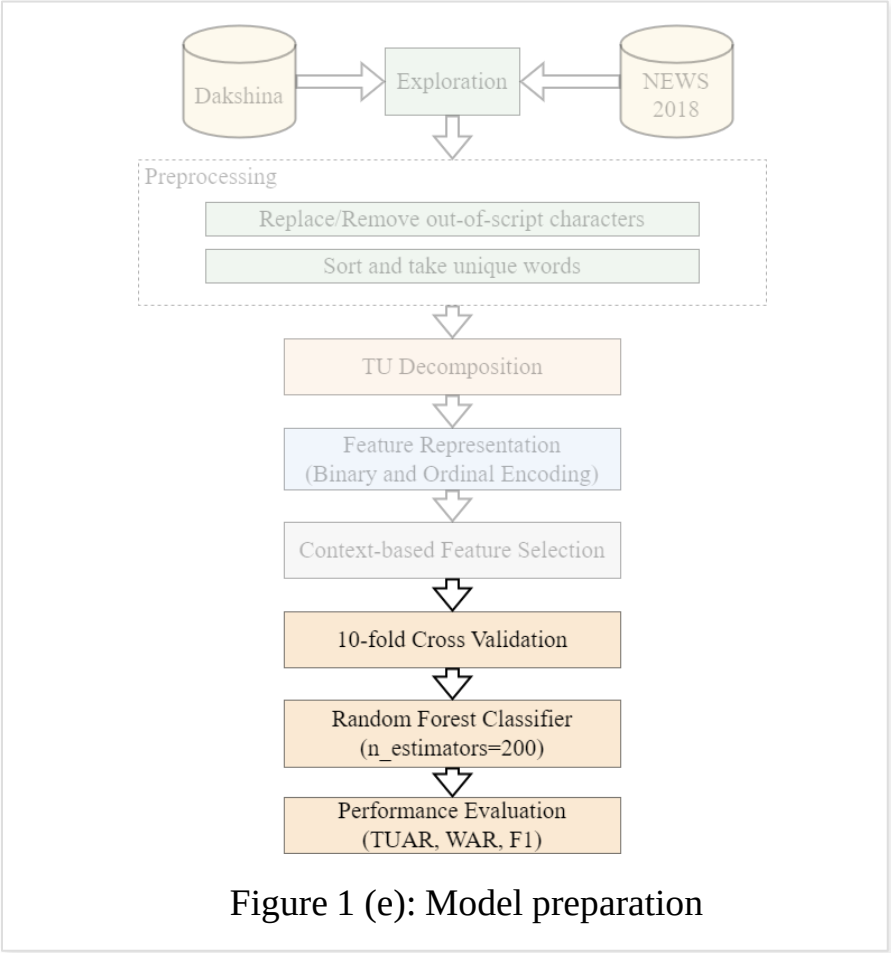


Figure 1 (e): Model preparation

# Results

- Baseline: Model A or context-free model
- For Dakshina and NEWS 2018 Datasets

Table 3: Performance on Forward Transliteration

| Model | Dakshina | | | NEWS 2018 | | |
|---|---|---|---|---|---|---|
| | TUAR | WAR | F1 Score | TUAR | WAR | F1 Score |
| Model A | 77.63 | 45.73 | 74.57 | 76.76 | 44.96 | 73.04 |
| Model B | 78.53 | 47.03 | 77.05 | 78.32 | 48.23 | 75.97 |
| Model C | **80.76** | **50.70** | 79.20 | **81.04** | **53.62** | **78.56** |
| Model D | 77.80 | 46.19 | 75.80 | 78.07 | 47.70 | 74.91 |
| Model E | 80.68 | 50.44 | **79.22** | 80.78 | 53.09 | 78.27 |
| Model F | 80.64 | **50.70** | 78.93 | 80.48 | 52.14 | 77.42 |

# Results

- Baseline: Model A or context-free model
- For Dakshina and NEWS 2018 Datasets

Table 4: Performance on Backward Transliteration

| Model | Dakshina | | | NEWS 2018 | | |
|---|---|---|---|---|---|---|
| | TUAR | WAR | F1 Score | TUAR | WAR | F1 Score |
| Model A | 73.57 | 37.25 | 68.37 | 68.90 | 33.56 | 63.87 |
| Model B | 75.71 | 40.52 | 73.68 | 70.03 | 32.78 | 67.44 |
| Model C | 76.46 | 40.17 | 74.47 | 72.44 | 36.10 | 70.59 |
| Model D | 73.91 | 37.71 | 71.04 | 68.09 | 30.03 | 65.23 |
| Model E | **78.41** | **44.28** | **76.91** | **73.12** | **37.84** | **71.09** |
| Model F | 77.73 | 43.17 | 75.79 | 72.55 | 36.88 | 70.36 |

# Contributions

- Contextual feature selection with binary coding for the Bengali language
- Provides algorithm for context-based feature selection
- Explores performance on forward and backward transliteration

# Conclusion

- Grapheme-based approach
- Binary encoding technique
- Influence of contextual information within words

# Future Research Direction

Investigate transliteration variations

Apply Deep Learning techniques

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# Thank You

# Variations in words

| Original | Transliterated |
| --- | --- |
| ফুল | Phool, phul, fool, ful |