Poetic Machine
Computational Creativity for Automatic
Poetry Generation in Bengali

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Stockholm, Sweden
Collaborative Poetry Generation

- Fully automatic vs. in collaboration with the user
- Complete poem vs. one poetry line at the time
Collaborative Poetry Generation

• Fully automatic vs. in collaboration with the user
• Complete poem vs. one poetry line at the time

1. The user enters a line of text
2. The system generates a matching, rhyming line
Collaborative Poetry Generation

- Fully automatic vs. in collaboration with the user
- Complete poem vs. one poetry line at the time

1. The user enters a line of text
2. The system generates a matching, rhyming line

- Rhyme understanding
  - Parsing input to understand poetic structure
- Rhyme generation
  - Output structure prediction
  - Candidate word generation
Poetry Evaluation

Criteria [Manurung 2004]:
- Meaningfulness
- Grammaticality
- "Poeticness"
Poetry Evaluation

Criteria [Manurung 2004]:

- Meaningfulness
- Grammaticality
- "Poeticness"

- In-depth / expert evaluation
- Random user evaluation
Bengali (Bangla)

- Spoken in Bangladesh and Eastern India
- 7th largest language in the World (2nd in India)
- Partially phonemic
  - pronunciation depends on part-of-speech and semantics
Bengali (Bangla)

- Spoken in Bangladesh and Eastern India
- $7^{th}$ largest language in the World ($2^{nd}$ in India)
- Partially phonemic
  - pronunciation depends on part-of-speech and semantics
- Orthography derived from Sanskrit
- Characters = *akṣara*
  - 7 vowels
  - 4 semi-vowels
  - 30 consonants
- (Phonetic) Consonant group = *borgo*
# Borgo-Phonetic Groups

<table>
<thead>
<tr>
<th>Borgo</th>
<th>Consonants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>k-borgo</strong> (ক)</td>
<td>ক(k)  খ(kʰ)  গ(g)  ঘ(gʰ)  ঙ(ŋ)</td>
</tr>
<tr>
<td><strong>tʃ-borgo</strong> (চ)</td>
<td>ছ(ıtʃʰ)  ঝ(ʃʰ)  ঞ(n)</td>
</tr>
<tr>
<td><strong>t-borgo</strong> (ট)</td>
<td>ঠ(ʈʰ)  ড(ɖ)  ঢ(ɽ)</td>
</tr>
<tr>
<td><strong>t-борго</strong> (ত)</td>
<td>ত(ʈ)  থ(ʈʰ)  দ(ɖ)  ধ(ɖʰ)  ন(ŋ)</td>
</tr>
<tr>
<td><strong>p-borgo</strong> (প)</td>
<td>প(p)  ফ(ᵞpʰ)  ব(b)  ভ(bʰ)  ম(m)</td>
</tr>
<tr>
<td>Internal sound</td>
<td>ৠ(ɖং)  ৡ(e)  ৡ(r)  ৡ(l)</td>
</tr>
<tr>
<td>Warm sound</td>
<td>ৡʃ  ৡʃ  ৡs   الرح</td>
</tr>
<tr>
<td>Scolding sound</td>
<td>ৡɽ  ৡɽ</td>
</tr>
<tr>
<td>Parasitic sound</td>
<td>ৡڲ(ڲ)   '%$</td>
</tr>
</tbody>
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<td>ক(ক) খ(কʰ) গ(গ) ঘ(গʰ) ঙ(ঙ)</td>
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<tr>
<td><strong>ṭf-borgo (চ)</strong></td>
<td>চ(টং) ছ(টংʰ) জ(ঝং) ঝ(ঝংʰ) ঞ(ঞ)</td>
</tr>
<tr>
<td><strong>t-borgo (ট)</strong></td>
<td>ট(ট) ঠ(টʰ) ড(ড) ঢ়(ঢ়ʰ) ণ(ণ)</td>
</tr>
<tr>
<td><strong>ṭ-borgo (ত)</strong></td>
<td>ত(ট) থ(টʰ) দ(ঢ়) ধ(ঢ়ʰ) ন(ঞ)</td>
</tr>
<tr>
<td><strong>p-borgo (প)</strong></td>
<td>প(প) ফ(পʰ) ব(ব) ভ(ভং) ম(ম)</td>
</tr>
<tr>
<td><strong>Internal (স্থিতি) sound</strong></td>
<td>য(যঃ) য়(য়) র(র) ল(ল)</td>
</tr>
<tr>
<td><strong>Warm (মান) sound</strong></td>
<td>শ(ʃ) ষ(ʃ) স(ʃ) হ(ʃ)</td>
</tr>
<tr>
<td><strong>Scolding (তাজনড়াত)</strong></td>
<td>ড়(r) ঢ়(r)</td>
</tr>
<tr>
<td><strong>Parasitic (ীয়শৃংহারপ)</strong>*</td>
<td>৩ঊ(h) ৬(η)</td>
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*Note: Less-stressed sounds are indicated by an asterisk (*) in the original document.*
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<td>ট (t)  ঠ (tʰ)  ড (ɖ)  ঢ (ɽ)  ণ (n)</td>
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<tr>
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</tr>
<tr>
<td>Internal (স্বতন্ত্র) sound</td>
<td>য (ʃ)  য় (e̯)  র (ɾ)  ল (l)</td>
</tr>
<tr>
<td>Warm (স্ন্যান) sound</td>
<td>শ (ʃ)  ষ (ʃ)  স (s)  হ (h)</td>
</tr>
<tr>
<td>Scolding (তাজনডাত)</td>
<td>ড় (r)  ঢ় (ɽ)</td>
</tr>
<tr>
<td>Parasitic (য়শারপ)</td>
<td>ঋ (h)  ঊ (η)</td>
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<td>t̪-borgo (ত)</td>
<td>ত (t̪)</td>
</tr>
<tr>
<td>p-borgo (প)</td>
<td>প (p)</td>
</tr>
<tr>
<td>Internal (স্বপ্ন্ততাচ্ছ) sound</td>
<td>য (ʧ)</td>
</tr>
<tr>
<td>Warm (স্বু) sound</td>
<td>শ (ʃ)</td>
</tr>
<tr>
<td>Scolding (তাজন্ডাতে)</td>
<td>ড (ɽ)</td>
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<tr>
<td>Parasitic (রায়শরাপ)</td>
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Bengali Poetry

- **Syllables**
  - **Closed** = ends in vowel
  - **Open** = ends in consonant
Bengali Poetry

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• **Metres**
  – *Akṣara-vṛtta* – based on the number of syllables
  – *Mātrā-vṛtta* – based on the vowel length
  – *Svara-vṛtta* – based on the vowel number
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• **Rhymes / alliterations**
  – **Adiprāsa** - **first** syllable rhymes
  – **Dviteeyakshara prāsa** - **second** syllable rhymes
  – **Antyaprāsa / anto-mil** - **last** syllable rhymes (tail-rhyme)
Bengali Poetry

• **Syllables**
  - *Closed* = ends in vowel
  - *Open* = ends in consonant

• **Metres**
  - *Aksara-vṛtta* – based on the number of syllables
  - *Mātrā-vṛtta* – based on the vowel length
  - *Svara-vṛtta* – based on the vowel number

• **Rhymes / alliterations**
  - *Adipraśa* - first syllable rhymes
  - *Dviteeyakshara prāsa* - second syllable rhymes
  - *Antyapraśa* / *anto-mil* - last syllable rhymes (tail-rhyme)
Poetry Corpus

- Downloaded from poetry sites on the net
- Mainly children poems by Sukumar Ray (+ Tagore)
- Written in *mātrā-vṛtta* metre with *anto-mil* rhyme
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<table>
<thead>
<tr>
<th>Units</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sentences</td>
<td>3567</td>
</tr>
<tr>
<td>Words</td>
<td>9336</td>
</tr>
<tr>
<td>Unique Tokens</td>
<td>7245</td>
</tr>
</tbody>
</table>
Poetry Generation Model

• Inspired by Satyajit Ray’s movie ‘Kingdom of Diamonds’ (1980)

• Entire conversation in rhythm

এরা যত বেশি পড়ে
ērā yata bēṣi pārē
*(the more they read)*

তত বেশি জানে
tata bēṣi jānē
* (the more they learn)*

তত কম মানে
tata kama mānē
* (the less they obey)*
Poetry Generation Model

Rhyme Understanding

Syllable Identification

Borgo Identification
Poetry Generation Model

Rhyme Understanding

Syllable Identification

Borgo Identification

Rhyme Generation

Syllable Sequence Prediction

Word Selection

Pruning and Grammaticality
1. Rhyme Understanding

1a. Syllable Identification

Grapheme to phoneme converter [Basu et al. 2009]

- Words starting with vowel = marked ‘v’
- Other words = marked with borgo group
1. Rhyme Understanding

1a. Syllable Identification

Grapheme to phoneme converter [Basu et al. 2009]

- Words starting with vowel = marked ‘v’
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<table>
<thead>
<tr>
<th>Input</th>
<th>আকাশের akasher</th>
<th>ময়দানে maẏadane</th>
<th>বাতাসের bataser</th>
<th>ভরে bharē</th>
</tr>
</thead>
<tbody>
<tr>
<td>ইংরেজী</td>
<td>In the sky with the air</td>
<td>আকাশের ākāśēra</td>
<td>ময়দানে maẏadānē</td>
<td>বাতাসের bātāsēra</td>
</tr>
<tr>
<td>Syllables</td>
<td>ākā-śē-ra</td>
<td>maẏa-dānē</td>
<td>bā-tā-sēra</td>
<td>bharē</td>
</tr>
<tr>
<td>Syllable count</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Open/Closed</td>
<td>o</td>
<td>c</td>
<td>o</td>
<td>c</td>
</tr>
<tr>
<td>Borgo</td>
<td>v</td>
<td>p</td>
<td>p</td>
<td>p</td>
</tr>
</tbody>
</table>
1. Rhyme Understanding

1b. Borgo Identification

• For open syllabic (consonant-ending) words:
  Can use a word ending with a C from the same borgo

• Example: ঠ(ṭh) and ট(ṭ) are both in ʈ-borgo

  বুড়ো বুড়ো ধাড়ি মেঘ চিপি হয়ে উঠে
  
  buṛō buṛō dhāṛi mēgha ḍhipi haẏe uṭhē
  (the very old inveterate cloud looks like a hill)

  শুয়ে বসে সভাকের সারাদিন জুটে।
  
  śuẏe ba’sē sabhā karē sārādina juṭē
  (they were meeting all day with the gathered friends)
2. Rhyme Generation

a. Syllabic Sequence Prediction

Support Vector Machines (WEKA; Hall et al. 2009)

• Corpus split into training and test sets
• Training set split into rhyming sentence pairs
2. Rhyme Generation

a. Syllabic Sequence Prediction
Support Vector Machines (WEKA; Hall et al. 2009)
- Corpus split into training and test sets
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- Features:
  - Syllable count sequence
  - Open/closed syllable pattern sequence
  - *Borgo* group marking sequence
2. Rhyme Generation

a. Syllabic Sequence Prediction

Support Vector Machines (WEKA; Hall et al. 2009)

- Corpus split into training and test sets
- Training set split into rhyming sentence pairs
- Features:
  - Syllable count sequence
  - Open/closed syllable pattern sequence
  - Borgo group marking sequence
- Three ML engines trained:
  1. Initial position
  2. Final position
  3. All intermediate positions
2. Rhyme Generation

b. Word Selection

- Word collection: poetry corpus + news corpus
- Syllable counts from grapheme to phoneme converter
2. Rhyme Generation

b. Word Selection

- Word collection: poetry corpus + news corpus
- Syllable counts from grapheme to phoneme converter
- Search space pruning:
  1. Syllable-wise similarity
  2. Open/closed syllable
  3. Semantic relevance
  4. *Borgo*-wise similarity
  5. Tail-rhyme (*anto-mil*) matching
    - Based on minimum edit distance for the final word
Semantic Relevance

- Essential for generating meaningful rhymes
Semantic Relevance

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• Process:
  1. Stemming
     - Bengali shallow parser
Semantic Relevance

- Essential for generating meaningful rhymes
- Process:
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  2. Translation by dictionary look-up
     - English-Bengali dictionary (Biśvās 2000)
Semantic Relevance

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  3. Concept matching
     - Only verbs and nouns
     - English ConceptNet (Havasi et al. 2007)
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     - Only verbs and nouns
     - English ConceptNet (Havasi et al. 2007)
  4. Relevance matching
     - Selected and given words co-occur in ConceptNet
Semantic Relevance, Example

• If the given line is:
  আকাশের ময়দানে বাতাসের ভরে
  \( \text{ākāśēra maẏadānē bātāsēra bharē} \)
  \( \text{the sky is filled with the air from the fields} \)

• ConceptNet look-up will be for:
  – sky (আকাশ), field (ময়দান), air (বাতাস)
Semantic Relevance, Example

• If the given line is:
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  the sky is filled with the air from the fields

• ConceptNet look-up will be for:
  – sky (আকাশ), field (ময়দান), air (বাতাস)

• The extracted word list will contain ‘cloud’ (মেঘ)

• Originally used by Sukumar Ray in ‘Cloud Whims’:
  ছোট বড় সাদা কালো কত মেঘ চরে|
  chōṭa baṛa sādā kālō kata mēgha carē
  many large and small, black and white clouds are grazing
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  *the sky is filled with the air from the fields*

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  *many large and small, black and white clouds are grazing*

  “gibberish /... /not what i would call good poetry”
2. Rhyme Generation

c. Pruning and Grammaticality

1. Bi-gram matching
   - Same word collection (poetry + news)
   - Weights for all bi-grams (frequency / total number of unique)
2. Rhyme Generation

c. Pruning and Grammaticality

1. Bi-gram matching
   - Same word collection (poetry + news)
   - Weights for all bi-grams (frequency / total number of unique)

2. Aggregation
   - Best combination = maximizing the weighted path
Evaluation: Criteria (scales 1-3)

- Poeticness
  - 3 = Rhythmic
  - 2 = Partially rhythmic
  - 1 = Not rhythmic

- Grammaticality
  - 3 = Grammatically correct
  - 2 = Partially grammatically correct
  - 1 = Not correct

- Meaningfulness
  - 3 = Meaningful
  - 2 = Partially meaningful
  - 1 = Not meaningful
Evaluation: Evaluators

• In-depth / three experts
  – 100 input sentences each
Evaluation: Evaluators

- In-depth / three experts
  - 100 input sentences each
  1. Literature student
     - Simple poem lines (from Satyendranath Dutta’s work)
Evaluation: Evaluators

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2. Journalist
   • News line input (short, ‘poetic-like’ sentences)
Evaluation: Evaluators

• In-depth / three experts
  – 100 input sentences each
  1. Literature student
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  2. Journalist
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  3. Technology student
     • Modern Bengali songs (short & simple sentences)
Evaluation: Evaluators

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• Ten random users
  – 5 of them: restricted input (≤ 5 words)
  – 5 of them: unlimited input length (∞)
Reasonable Output

• Poetry (Satyendranath Dutta: ‘Song of the Palanquin’ / ‘Palkir Gan’)

46
Reasonable Output

- Poetry (Satyendranath Dutta: ‘Song of the Palanquin’ / ‘Palkir Gan’)
  - পালকী চলে  U: Pālakī cālē  *Palanquin moves!*
  - দুলকি চালে  S: Dulaki cālē  *Trot pace*
Reasonable Output

• Poetry (Satyendranath Dutta: ‘Song of the Palanquin’ / ‘Palkir Gan’)
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  – স্তব্ধ গাঁয়ে  U: Stabdha gāmŷē    Stunned village
  – রুদ্ধ দ্বারে  S: Rud'dha dbārē    Cloggy doors
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  – রুদ্ধ দ্বারে  S: Rud'dha dbārē  Cloggy doors

• News (Bartanam newspaper: http://bartamanpatrika.com)
  – কে হবেন প্রধানমন্ত্রী?  U: Kē habēna pradhānamantrī?
    Who will be the prime minister?
  – গদি নেওয়ার ষড়য়ন্ত্রী  S: Gadi nē'ōẏāra ṣaṛayantrī
    Conspirator for the throne
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• Lyrics (modern Bengali songs)
  – গভীরে যাও U: Gabhīrē yāō Dive into the depth of your heart
  – শুধুরে নাও S: Śudharē nāō Rectify yourself
Reasonable Output

• Poetry (Satyendranath Dutta: ‘Song of the Palanquin’ / ‘Palkir Gan’)
  – পালকী চলে  U: Pālakī calē    Palanquin moves!
  – দুলকি চালে  S: Dulaki cālē    Trot pace
  – স্তব্ধ গাঁয়ে  U: Stabdha gām̐ẏē    Stunned village
  – রুদ্র দ্বারে  S: Ruḍ'dha dbārē    Cloggy doors

• News (Bartanam newspaper: http://bartamanpatrika.com)
  – কে হবেন প্রধানমন্ত্রী ?  U: Kē habēna pradhānamantrī?
     Who will be the prime minister?
  – গদি নেওয়ার ষড়যন্ত্রী  S: Gadi nē'ōẏāra ṣaṛayantrī
     Conspirator for the throne

• Lyrics (modern Bengali songs)
  – গভীরে যাও  U: Gabhīrē yā'ō    Dive into the depth of your heart
  – শুখরে নাও  S: Śudharē nā'ō    Rectify yourself

Plus many bad!
Evaluation: Results

<table>
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<th>Evaluators</th>
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<th>Random</th>
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- **Poetry**: poetry
- **News**: news
- **Lyrics**: lyrics
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Summary

• Interactive rhyme generation
• One matching line
• Rules and metres of Bengali poesi
Summary

- Interactive rhyme generation
- One matching line
- Rules and metres of Bengali poesi

Strategy:
- Bengali syllabification engine
- SVM-based structure prediction
- Word candidates by semantic relevance (ConceptNet)
- Word selection by bi-gram pruning