Japanese Kanji Suggestion Tool

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Outline

- Introduction
- Prior work in Japanese word segmentation
- Hidden Markov Model for text parsing
- Design and implementation
- Experiments and results
- Conclusion

Introduction

- Motivation
    - “No search results found” message on typing wrong kanjis
    - Meaningless translations of wrong Japanese word
- Goal
    - Provide simple suggestions to Japanese language beginners

Prior work in Japanese word segmentation

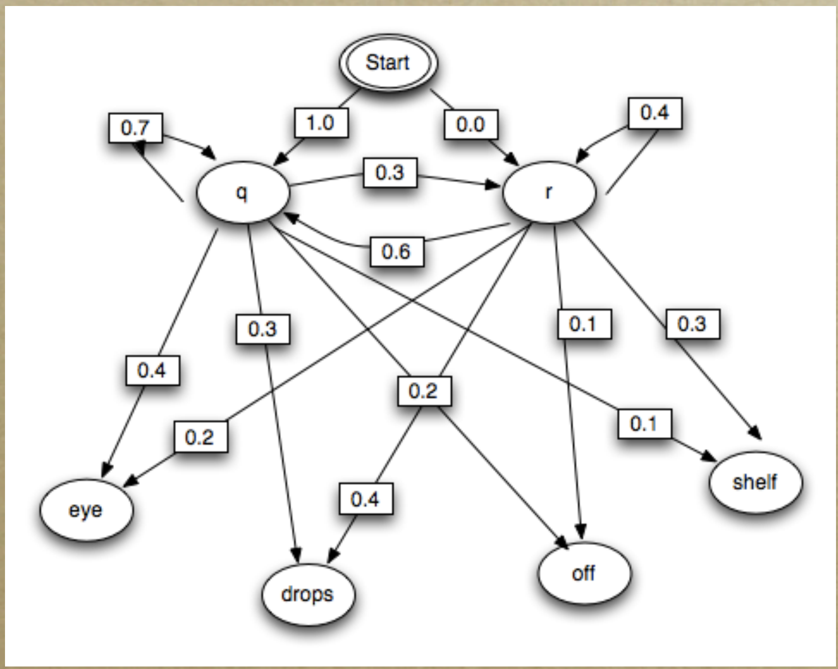
- JUMAN morphological analyzer
  - Rule-based morphological analyzer
  - Cost to lexical entry and cost to pairs of adjacent parts-of-speech
  - labor-intensive and vulnerable to unknown word problem
- TANGO algorithm
  - Based on 4-gram approach
  - Series of questions to get a word boundary
  - More robust and portable to other domains and applications

Prior work in Japanese word segmentation (cont..)

- Existing search engines
  - Google
  - Yahoo!
  - Bing

Hidden Markov Model for text parsing

- What is the Hidden Markov Model?
  - It is a variant of a finite state machine having a set of hidden states



N = the number of states

M = the number of observation symbols

$Q = \{q_i\}, i = 1,\ldots\ldots,N$

A = the state transition probabilities

B = the observation probability matrix

π = *the initial state distribution*

$O = \{o_k\}, k = 1,\ldots., M$

Hidden Markov Model for text parsing (cont..)

- Working of the Hidden Markov Model
    - Three problems related to the Hidden Markov Model

1. Given the model λ and a sequence of observations, find out the sequence of hidden states that leads to the given set of observations - Viterbi algorithm
2. Given the model λ and a sequence of observations, find out the probability of a sequence of observations - Forward or Backward algorithm
3. Given an observation sequence O and the dimensions N and M, find the model $\lambda = (A, B, \pi)$, that maximizes the probability of O - Baum-Welch algorithm or HMM training

Design and implementation

- Japanese language processing
  - Hiragana, katakana and kanji
  - Japanese characters encoding
- Hidden Markov Model program details
  - Number of iterations
  - Number of observations
  - Number of states

Design and implementation (cont..)

- Japanese corpus - Tanaka
  - Corpus file format

    A: ＆という記号は、ａｎｄを指す。[TAB]The sign '&' stands for 'and'.#ID=1

    B: と言う{という}~ 記号~ は を 指す[03]~
  - Modifications in the corpus file
- The software
  - JDK1.6, Tomcat 5.5, Eclipse IDE

Design and implementation (cont..)

- The Nutch web crawler (GUI)
  - Open source web crawler
  - Domain name to crawl japanese websites, google.co.jp
  - Command to crawl:

    bin/nutch crawl urls -dir crawljp -depth 3 -topN 10

    -depth: Indicates the link depth from the root page that should be crawled

    -topN: Determines the maximum number of pages that will be retrieved at each level up to the depth
  - Agent name in nutch-domain.xml as google

Design and implementation (cont..)

- Searcher.dir property tag in nutch-site.xml as path to crawljp directory
- Instant search functionality: Find-as-you-type

Experiments and results

- Hidden Markov Model - English text
  - Understanding how the Hidden Markov Model converges
  - Distinguish between consonants and vowels, letters a, e, i, o, u have the highest probabilities and appears in the first state
  - The observation ‘space’ has the highest probability among all 27 observations

Experiments and results (cont..)

- Hidden Markov Model - Japanese text
    - Frequently used characters (あ、い、う、お、で、の):

      higher probabilities but no clear distinction for word boundaries
    - HMM final probability matrices are serializable and stored in a file
    - Viterbi program reads serialized object from a file and appends hiragana characters at the end of the user input string
    - Verify the string returned from Viterbi program exists in Tanaka Corpus

Experiments and results (cont..)

- N-gram experiments using Tanaka Corpus

1. Experiment 1:

- Aim: To find suggestions for a possible next character
- Results: List of the first three most common words that begin with the user entered string
- Description:

- Binary tree node consists of <key(word of length 3), value (number of occurrences)> pair
- Any special character is stored as ‘EOW’ (End Of Word)

Experiments and results (cont..)

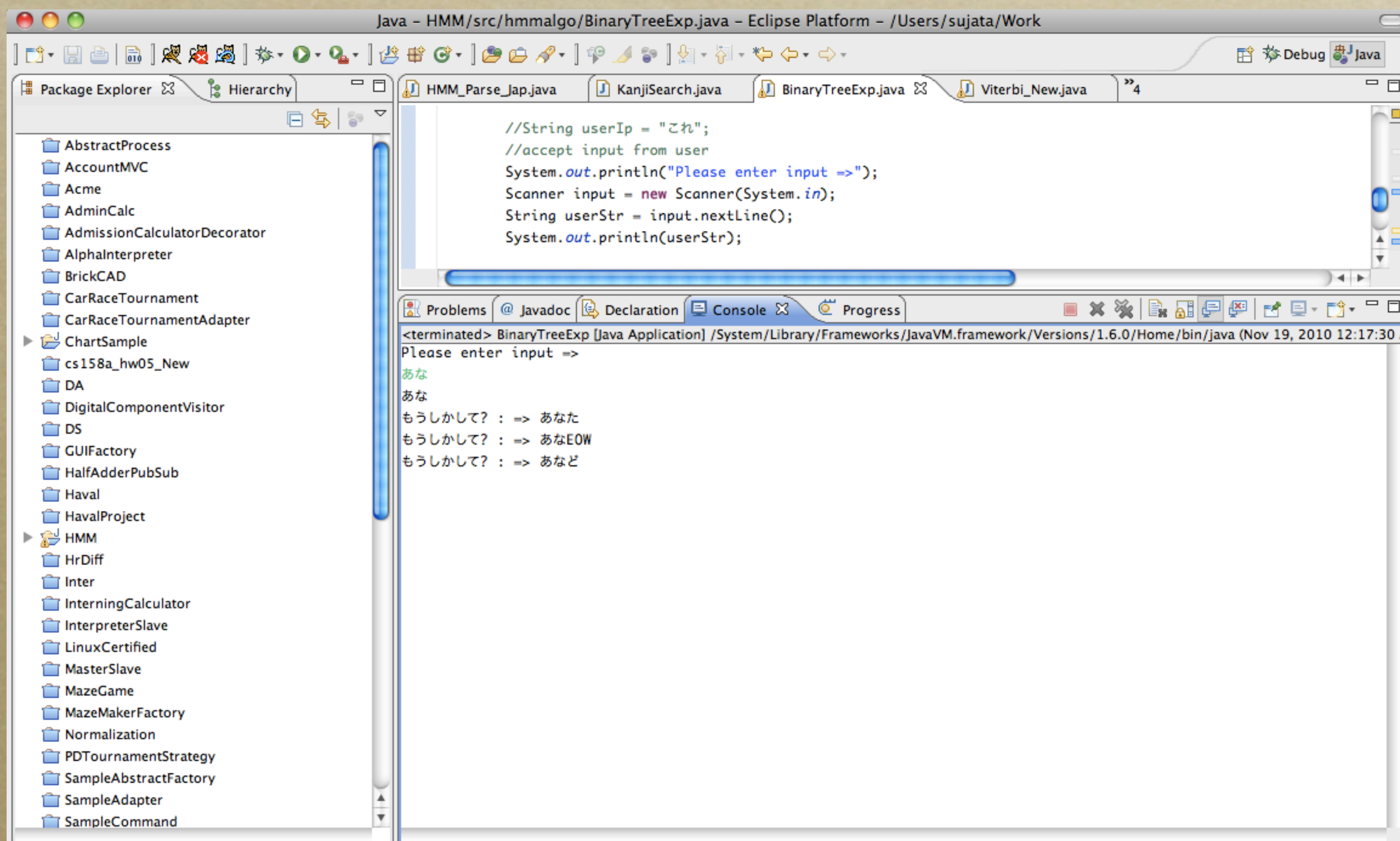
1. Experiment 1:

- Description:

- When user enters the input, look for the words starting with the user input and having the highest number of occurrences

Experiments and results (cont..)

1. Experiment 1:



Experiments and results (cont..)

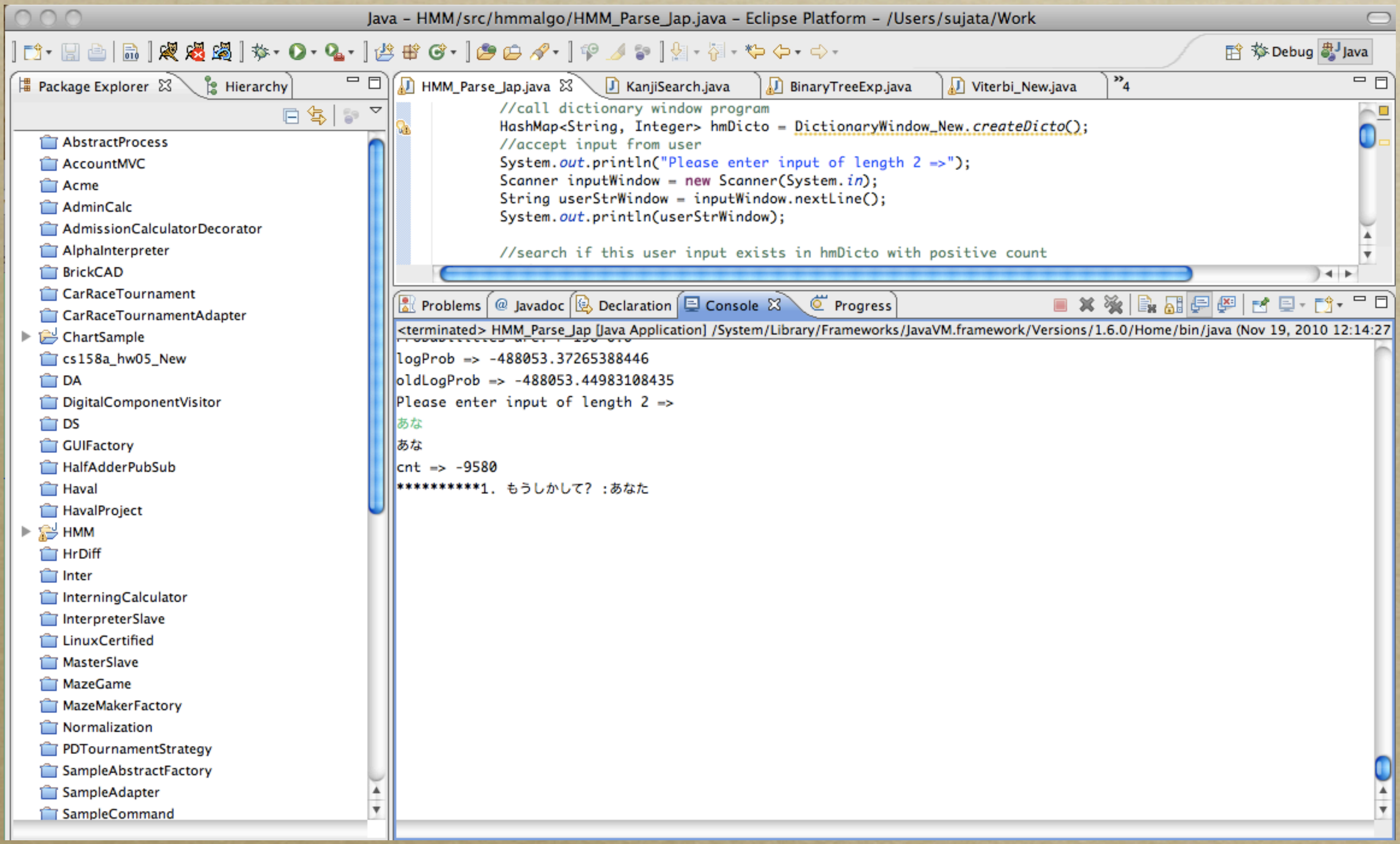
2. Experiment 2:

- Aim: To find out word boundaries
- Results: Single word that begin with the user entered string
- Description:

- Iterate through Tanaka Corpus reading string of length three
- String ending with the special character: subtract 1 else add 1
- Find out words having positive number of occurrences indicating end of word

Experiments and results (cont..)

2. Experiment 2:



Experiments and results (cont..)

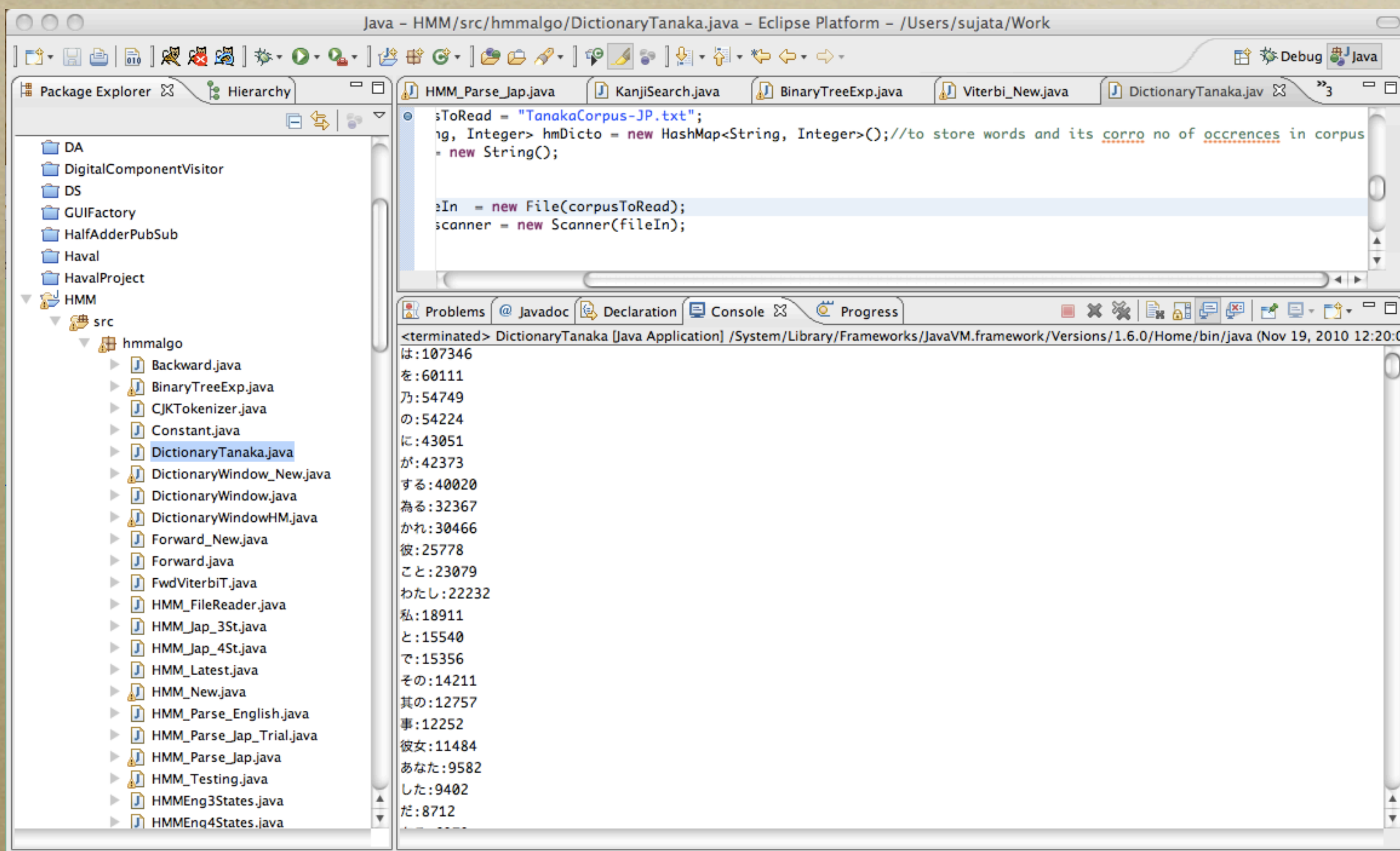
3. Experiment 3:

- Aim: To find out all Japanese words in the corpus file
- Results: List of Japanese words
- Description:

- Creates Japanese word dictionary
- Can be used in information security

Experiments and results (cont..)

3. Experiment 3:

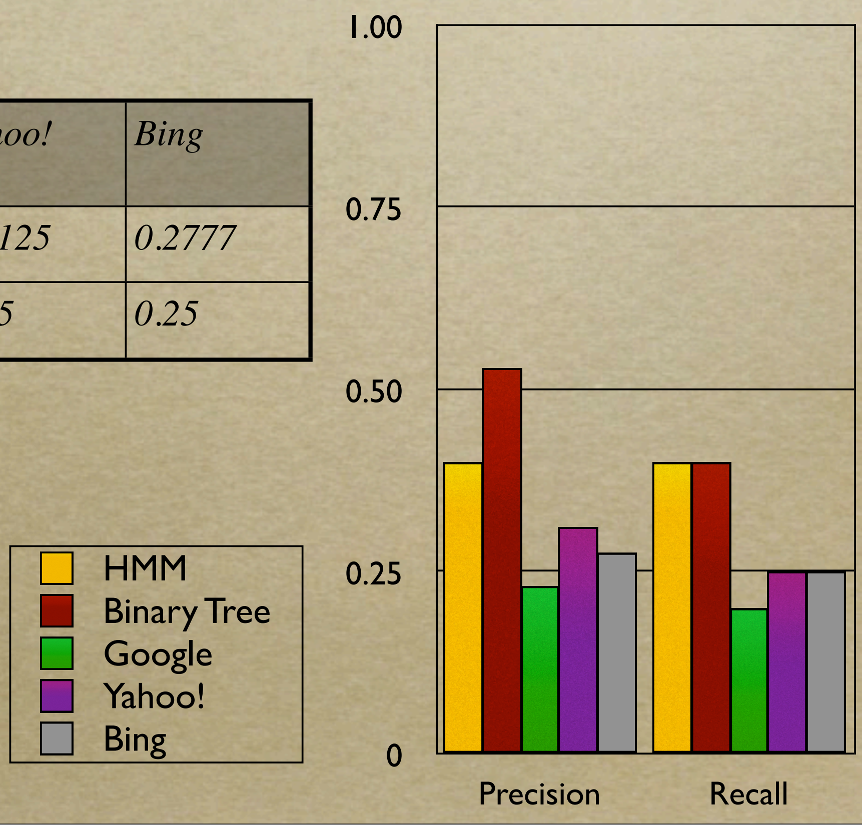


Experiments and results (cont..)

4. Experiment 4: Precision and recall

- Aim: To evaluate the correctness of the outputs
- Results:

	HMM	*Binary Tree*	*Google*	*Yahoo!*	*Bing*
Precision	*0.4*	*0.53*	*0.23*	*0.3125*	*0.2777*
Recall	*0.4*	*0.4*	*0.2*	*0.25*	*0.25*



Experiments and results (cont..)

4. Experiment 4: Precision and recall

- <u>Description</u>:

- $$\text{Precision} = \frac{|\{\text{relevant results}\} \cap \{\text{retrieved results}\}|}{|\{\text{retrieved results}\}|}$$

- $$\text{Recall} = \frac{|\{\text{relevant results}\} \cap \{\text{retrieved results}\}|}{|\{\text{relevant results}\}|}$$

Experiments and results (cont..)

4. Experiment 4: Precision and recall

- Description:

- Two lettered string experiment for calculating precision and recall
- 20 strings of length two are given to Japanese Professor and native Japanese friend
- They provided us most frequently used words for the given 20 strings
- This is our measure for calculating precision and recall values
- Check if suggestions given by HMM and binary tree and search engines match with the strings provided by humans

Conclusion

- Difficulties
    - Handling large number of observations
    - Randomly generating initial probability matrix
    - Japanese character charset issues
- Precision and recall
    - N-gram approach gives good results as compared to HMM
- Future work
    - Recognition of all different kanji symbols

References

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ありがとうございました。