Annotation of Spelling Errors for Korean Learner Corpora

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Introduction

- Learners frequently make spelling errors in Korean (Ko et al 2004)
  - Errors reflect aspects of linguistic knowledge (cf. Rimrott & Heift 2008, and references therein)
    - In Korean: frequent mismatches between a syllable and a character, due to phonological rules and morphological boundaries
  - Errors are computationally problematic (e.g., van Rooy & Schäfer 2002, de Felice & Pulman 2008)
- Goal: Provide taxonomy & annotation scheme for Korean learner spelling errors
  - Useful for automatic error diagnosis
  - Useful for feedback instruction in a Korean ICALL system

Overview

- Background on Korean
  - Korean writing system
  - Korean word formation
- Error taxonomy
- Corpus Study
  - Interannotator agreement with pilot corpus
  - Abilities of current spelling checkers
  - Spelling Error Analysis with 100 Learner corpus

Korean writing system

- Syllabic alphabet with one umjeol 'syllable', as a basic unit
- A syllable is composed of at most 3 components:
  - choseong, the first sound, e.g., ㅎ [h]
  - jungseong, the second sound(s), e.g., ㅏ [a]
  - jongseong, the last sound(s), e.g., ㄱ [k]
- Syllable is represented combinatorically, e.g., 학 [hak]
  - unlike the more linear representation for English

Korean writing system

Syllabic representation of the Korean writing system requires learners to acquire:

- Linguistic knowledge of exact syllable compositions
  - e.g., for 학기 [hakki] 'semester':
    - the first ㄱ [k] combines with the preceding vowel ㅏ [a]
    - the second ㄱ attaches to the following vowel ㅣ [i]
- Specific orthographic knowledge, including sound-letter relationships
  - e.g., [k] and [g] sounds both correspond to ㄱ
- Positional constraints of letter patterns
  - e.g., double consonant ㄵ [nj]/[n] does not appear word initially

Korean word formation (1)

- As an agglutinative language, word formation in Korean has complex morphological combinations
  - Morphemic boundaries tend to be maintained in spite of application of a phonological rule.
- 잡-으시-었-겠-습니다 jap-eusi-eoss-kess-seupnita
  - Pronounced:
    자브시어께씀니다 ja-beu-si-eo-kkey-sseum-ni-da
  - Composed of 5 morphemes & orthographically maintains the basic dictionary form for each morpheme

Korean word formation (2)

- With a lack of linguistic awareness for morphological combinations, Korean language learners tend to depend on sound
  - Errors stem from lack of morphological knowledge
  - For English, phonological confusion plays a crucial role in error production (Hovermale, 2008)

Classifying errors

- Spelling errors range from simple mistakes to more linguistically complex errors (Kukich, 1992)
  - Mistakes result from inattention or physical conditions, including typos
  - Systematic errors reflect a lack of linguistic knowledge & require more informative feedback
    - lack of phonological awareness: phoneme discrimination, identification, or segmentation
    - lack of morphological awareness: morpheme identification or segmentation (words, particles, inflected verbal endings)

Error taxonomy

- An annotated corpus analysis can show
  - actual range of spelling errors of Korean learners
  - how each type of error is related to linguistic knowledge
    - related to learner's native language
    - related to deficit of phonological/morphological knowledge of Korean (cf., e.g., Rimrott & Heift, 2008).
- We classify 5 categories of spelling errors:
  - phonological, morphological, typographical, incomprehensible, foreign word
- Similar to Hovermale (2008), except errors with foreign words are separately marked

Phonological errors

- Phonological errors are based on:
  - incorrect mapping between a sound & a letter
    - Consonant mismatch ㅂ-ㅍ-ㅃ; ㄱ-ㅋ-ㄲ; ㄷ-ㅌ-ㄸ
      plain-tense-aspirated: [p, p',p^h];[k,k',k^h];[t,t',t^h]
      ex. correct form - 예**쁩**니다 incorrect form-예**븝**니다
      plain-tense; [s,s'];[ts,ts']
      ex. correct form - 날**씨**가 incorrect form-날**시**가
    - Vowel mismatch ㅗ-ㅓ; ㅜ-ㅡ
      ex. correct form: **노**래 incorrect form **너**래
- These types of errors are generally restricted to differences between Korean & English

Phonological errors

- Phonological distance between sounds can be remote
  - consonants: ㄱ[k] vs. ㅂ [p]

example:
correct 외**숙**모 [wesungmo] vs. incorrect 외**슙**모[wesupmo]

  - vowels: ㅏ [a] vs. ㅡ [eu]

example:
correct 나**빠**졌다 [nappajeotta] vs. incorrect 나**뻐**졌다 [nappeujeotta]

- This perceptual confusion is rare in native Korean

Morphological errors

- Morphological errors include:
  - failures of morpheme identification
    - Example. 먹+었+습니다 (ate)
      correct form 먹**었습**니다 incorrect form 먹**어씁**니다
    - Example. 맛[mat]+이[i] : [masi]
      correct form **맛이** incorrect form **마시**
  - double consonants 맑다[makta]
    correct form **맑**다는 incorrect **막**다는
  - overgeneralizations
    - Example 것+이+에요 이+에 →예
      correct form 것이**에**요 incorrect form 것이**예**요
- These errors are related to inflection, word syllabification, & syllable boundaries

Foreign word errors

- Foreign words in Korean borrowed from other languages often have non-predictable spelling
  - For example, the proper name *New York*
    - correct standard form: 뉴욕 *nyuyok*
    - commonly learner innovation: 뉴-요-크 *nyuyokhu*
- Closely related to phonological confusion
  - But hard to determine the exact match between a sound and a letter or identify the exact phonological rule

Distinguishing phonological & morphological errors

- Morphological variations caused by phonological rules have been treated as morphological errors

❖ Examples.

ㄹ assimilation : correct form **원**래 incorrect form **월**래

Phonological variants:

correct form부모님**과** [kwa] incorrect form 부모님**와**[wa]

correct form 한국말**을**[eul] incorrect form 한국말**를**[leul]

- Sometimes phonological variation disappears and become morphological variations.

Example. Sound distinction loss among native speakers

ㅐ [æ] vs. ㅔ [e]

correct form 한**테** incorrect form 한**태**

Typographical and incomprehensible errors

- Typographical errors
  - Criterion: student marked it correctly at other points
- Incomprehensible errors
  - It was unclear what was meant
- Both kinds of errors are similar to native speakers errors

Our approach

- Pilot study: Gather a small learner corpus of 10 people
  - 10 non-heritage intermediate learners with 1 article each
  - Test interannotator agreement for spelling annotation
  - Test accuracy of existing spelling checkers
- Actual annotation of data for 100 people
  - 25 heritage beginners, 25 non-heritage beginners
  - 25 heritage intermediates, 25 non-heritage intermediates

Interannotator agreement with pilot corpus

- We evaluated the Kappa statistic to measure interannotator agreement

1) Error Type: K=0.83 / 1281 pairs
   - P for phonological, M for Morphological, etc.
2) Correction: K=0.73 / 1281 pairs
   - Wrong word:Correct word pairs
   - e.g., 아**릅**답습니다: 아**름**답습니다 ---> to be beautiful
3) Feedback: K=0.75 / 1281 pairs
   - e.g., **ㅂ**:**ㅁ** ---> consonant **ㅂ**(p) should be replaced with consonant **ㅁ**(m)

- All 3 scores show high correlation between 2 annotators: positive results for our guidelines

Spelling checking

- Spell checkers for Korean do not adequately handle learner errors
  - Hypothesis: more morphological in nature
  - Closely related with word-spacing errors
- Learner errors:
  - require different error diagnostic tactics
  - need to support feedback
- Two spelling checkers used
  - HWP (Korean Word Processor)
  - HAM v.5 (Hangeul Analysis Module)

Accuracy of spelling checkers with a Pilot Corpus

- HWP (Korean word Processor)

	Raw Corpus	After Word-spacing Correction
Precision	0.717	0.927
Recall	0.551	0.551
F-measure	0.623	0.691

- HAM v.5

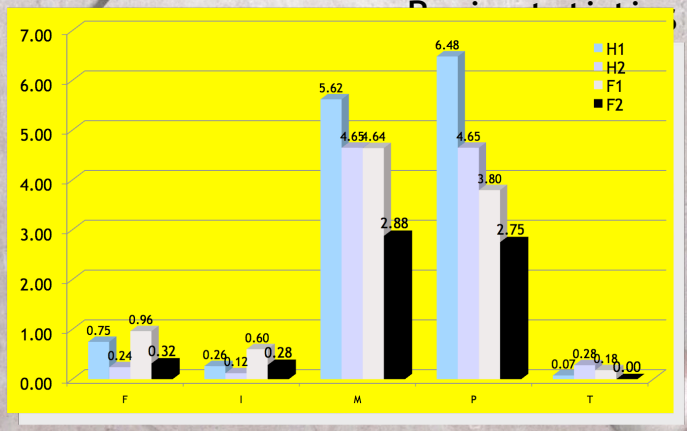
	Raw Corpus	After Word-spacing Correction
Precision	0.500	0.611
Recall	0.667	0.638
F-measure	0.571	0.624

Corpus of 100 Learners

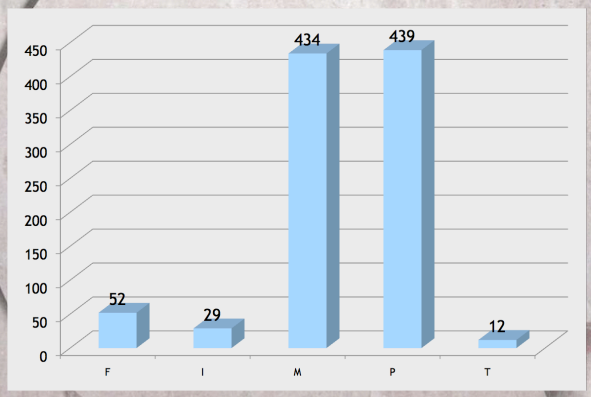
- Heritage Beginner: 2,669 words
- Heritage Intermediate: 2,496 words
- Non-heritage Beginner:1,659 words
- Non-heritage Intermediate:3,163 words

- 25 learners in each group

Corpus of 100 Learners



Corpus of 100 Learners



Analysis by background

	Heritage		Non-heritage		SUM	
	#	%	#	%	#	%
F	26	4.33	26	7.10	52	5.38
I	10	1.67	19	5.19	29	3.00
M	266	44.33	168	45.90	434	44.93
P	289	48.17	150	40.98	439	45.45
T	9	1.50	3	0.82	12	1.24
Total	600		366		966	

Analysis by language level

	Beginner		Intermediate		Sum	
	#	%	#	%	#	%
F	36	6.91	16	3.60	52	5.38
I	17	3.26	12	2.70	29	3.00
M	227	43.57	207	46.52	434	44.93
P	236	45.30	203	45.62	439	45.45
T	5	0.96	7	1.57	12	1.24
Total	521		445		966	

Spelling checking (HWP) on corpus of 100 learners

	H1		H2		F1		F2		Total	
	#	%	#	%	#	%	#	%	#	%
Checked w/ C	77	22.19	67	26.91	34	21.52	44	22.92	222	23.47
Checked w/o C	184	53.03	95	38.15	70	44.30	63	32.81	412	43.55
Not checked	86	24.78	87	34.94	54	34.18	85	44.27	312	32.98

Analysis of Phonological Errors

		H1	H2	F1	F2
# of Error Types	Consonants	17	24	17	30
	Vowels	25	34	24	21
	Total	42	58	41	51

Phonological Error Samples: Consonants & Vowels

	H1		H2		F1		F2	
	#	%	#	%	#	%	#	%
ㅐ : ㅔ	5	11.90	30	34.09	6	16.67	2	6.06
ㅗ : ㅏ	9	21.43	10	11.36	6	16.67	5	15.15
ㅏ : ㅐ	4	9.52	1	1.14	4	11.11	1	3.03
Total		42.86		46.59		44.44		24.24

Challenges

- For automatic spelling checking:
  - Need to account for learner errors, by a better morpheme:phoneme mapping?
- For corpus annotation development:
  - Collect & annotate more data
  - Integrate annotation with other types of annotation
    - use multi-layered annotation (cf. Lüdeling et al. 2005)

Conclusions

- With this annotated corpus:
  - Can improve evaluation for particle error detection (Lee, Eom, & Dickinson 2009)
  - Can test several methods of spelling error detection to determine their effectiveness for each error type
    - methods involving POS tagging, string similarity, machine learning, etc.
- Future: conduct experiments to find out the most effective feedback for each type of spelling errors

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