An Automatic Error Tagger for German

Inga Kempfert and Christine Köhn
Natural Language Systems Group
Department of Informatics
Universität Hamburg

{5kempfer,ckoehn}@informatik.uni-hamburg.de

Abstract

Automatically classifying errors by language learners facilitates corpus analysis and tool development. We present a tag set and a rule-based classifier for automatically assigning error tags to edits in learner texts. In our manual evaluation, the tags assigned by the classifier are considered to be the best or close to best fitting tag by both raters in 91% of the cases.

1 Introduction

For a variety of tasks, it is useful to classify errors by language learners into error types. E. g. corpora which are annotated with error types can be used to extract examples for compiling teaching material or exercises. Errors can only be interpreted sensibly with respect to a reconstructed utterance, a so-called target hypothesis (TH) (Reznicek et al., 2013). An error type characterizes the divergence between the learner utterance and the corresponding TH.

Manually annotating error types is a time-consuming task and has to be repeated if an error tagging scheme changes. Therefore, automatic error tagging is desirable and in some use cases even inevitable when manual annotation is not feasible due to the amount of data (e. g. when selecting training data from Wikipedia edits for Grammatical Error Correction (GEC) systems (Boyd, 2018) or when evaluating the performance of GEC systems (Bryant et al., 2017)) or due to an interactive setting (automatic error tags could be used as an information source for student modeling and feedback generation if a reliable GEC system is available). In addition, automatic annotation has the advantage that it can be used to easily unify error annotations across different corpora as long as some form of correction is available¹.

Inspired by ERRANT (Bryant et al., 2017), a grammatical ERRor ANnotation Toolkit for extracting and classifying edits in English learner texts, we developed an error annotation tool for German: Gerrant. It classifies edits extracted from already aligned parallel learner corpora and assigns error tags using a rule-based approach. An example for two edits from the ComiGS corpus (Köhn and Köhn, 2018) and their error tags is shown in in Table 1.

We present the system, the error types and the design decisions that lead to this set. Although we have a rather large and diverse tag set, the assigned tags were regarded as best fitting in most of the cases in our manual evaluation.

2 Related Work

There have been several approaches to classifying edits in learner texts automatically in the past. The Falko corpus (Reznicek et al., 2012, 2013) which consists of essays written by learner of German was automatically annotated with simple tags

Table 1: Example for two edits and their classification. The original text orig is aligned with the extended target hypothesis TH2. The edit at position 3 corrects a case error (error tag: S:ORTH), the other at position 5 inserts a determiner (I:DET). (ComiGS corpus, text 2mVs.2)

¹The TH may be created automatically by a Grammatical Error Correction system. Grundkiewicz and Junczys-Dowmunt (2018) achieved a performance close to humans for English.
### Table 2: Main error categories

| Tag  | Description                        |
|------|------------------------------------|
| ADJ* | Adjective error                    |
| ADV* | Adverb error                       |
| CONJ*| Conjunction error                  |
| CONTR| Contraction error                  |
| DET* | Determiner error                   |
| MORPH| Morphological error                |
| NOUN*| Noun error                          |
| OTHER*| Default category                |
| ORTH | Orthography error                  |
| PREP*| Preposition error                  |
| PUNCT| Punctuation error                  |
| SPELL| Spelling error                     |
| VERB*| Verb error                         |
| WO   | Word order error                   |

Every category can be prefixed with **S:** (substitution), categories marked with * can be combined with the prefixes **I:** (insertion) and **D:** (deletion). Word order errors have a special role (see text). Some categories have to be further specified to form a valid tag.

which classify the differences between the original and the target hypothesis based on the manual alignment into changes, insertions, deletions, merges, splits and movements.

ERRANT (Bryant et al., 2017) uses a more sophisticated approach and a broader tag set of 25 main error types for classifying edits in learner English. Most error types are based on the part of speech of the involved words. Since most of the types can be prefixed with "M:" (Missing), "R:" (Replacement) or "U:" (Unnecessary edit), there are 55 error categories in total. ERRANT uses the "linguistically-enhanced alignment algorithm" by Felice et al. (2016) for extracting the edits from a parallel corpus, which are then classified using a rule-based approach. ERRANT classifies edits based on automatically-obtained features such as PoS tag and dependency parse.

Recently, Boyd (2018) extended ERRANT to German and used it for enriching the training data for a GEC system by selecting edits from the German Wikipedia only for certain error types. This increased the performance of the GEC system over using all edits.

### 3 Error Types

Inspired by ERRANT and different manual error annotation schemes for German learner texts (Rogers, 1984; Boyd, 2010), we developed our set of error categories and error tags. Every tag is prefixed by either **S:** (Substitution), **D:** (Deletion) or **I:** (Insertion). Table 2 lists the main error categories. Most categories are based on the PoS of the involved words. We call the combination of prefix and main error category a coarse tag. Nearly all PoS-based coarse tags have to be further specified to form a precise tag. This is done by appending subcategories to the coarse tag, e.g. the coarse tag **S:DET** can be extended to **S:DET:NUM** to form the precise tag for determiner error in number. The complete list of precise error tags is shown in Appendix A.

Table 2: Main error categories. Every category can be prefixed with S: (substitution), categories marked with * can be combined with the prefixes I: (insertion) and D: (deletion). Word order errors have a special role (see text). Some categories have to be further specified to form a valid tag.

Insertions and deletions are either punctuation errors or certain PoS that have been inserted or deleted. Table 1 shows an example for inserting a determiner in the extended target hypothesis (TH2) from the ComiGS corpus (Köhn and Köhn, 2018).

Often an error involves more than one property of a word, e.g. a determiner might differ in case and gender. Therefore, we allow combinations of certain parts (see Appendix A) within the same coarse error tag with “;” (and), e.g. **S:DET:CASE_GEN** for determiner error in case and number. Some errors cannot be narrowed down to one error tag and we allow the combination of alternatives: Combinations are build with “;” between different error parts, e.g. **S:DET:CASE_GEN** means that the error is either a **S:DET:CASE** or a **S:DET:GEN** error, meaning Gerrant is unable to narrow down the error further. Combinations of alternatives and conjunctions are also possible as in **S:DET:CASE_GEN:NUM** (a determiner error in case and gender or a determiner error in number).

Although the error tags are token-based, the verb error **S:VERB:SV_A** (subject-verb agreement) includes syntactic errors but on the token level. Lexical confusions or semantic replacements are recognized either by the respective PoS-based category such as **S:VERB** if a verb was replaced with a semantically better fitting one or by **S:MORPH** if the tokens have the same stem, but different PoS.

If words are rearranged and changed at the same time, ERRANT classifies this only as a word order error or cannot recognize the word order error.

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2Note that even humans cannot always narrow the error down completely due to ambiguities.
at all. In contrast, Gerrant treats word order errors as token-based, i.e., instead of rearranging a span of tokens, individual tokens are moved which allows for an additional error tagging of the moved tokens. Because of this, the tag for word order errors `S:WO` has a special role: It is an error tag on its own if the moved token was not changed but it can also be a prefix for another error type, e.g., if the word moved was change from lower to upper case this would be a tagged as `S:WO:ORTH`.

Currently, Gerrant does not automatically align the input texts and since it relies on a manual alignment being available, it has only been used on the Falko corpus and the ComiGS corpus. The detailed classification of word order errors only works on the ComiGS corpus because tokens in that corpus are aligned via a so-called tokmovid (tmid) if they have been moved (Kohn and Kohn, 2018).

Also contrary to ERRANT, Gerrant is able to assign an error tag to discontinuous word errors e.g., if the original text is `ist [. . . ] liegend (“is lying”)` and the TH `liegt` (“lies”) and the tokens are annotated with a tokmovid, the error is tagged as `S:WO:VERB:FORM`, a combination of word order and verb form error. This is also important for classifying errors with separable verb prefixes because the verb and its prefix are often far apart (see `VERB:AVZ` in Table 5 in Appendix A).

### 4 Implementation and Rules

Gerrant uses several sources of information to classify an edit. It uses SpaCy for dependency parsing, PoS tagging and lemmatization, Cistem for stemming and DEMorphy for morphological analysis. We trained our own SpaCy model on the Hamburg Dependency Treebank (Foth et al., 2014) which uses the dependency scheme by Foth (2006) and the STTS tag set for PoS (Schiller et al., 1999).

Cistem is a state-of-the-art stemmer and segmenter for German and is available for several programming languages, including Python in which Gerrant is written. We chose Cistem over the Snowball stemmer provided by the python library nltk because it achieves better overall results.

We use DEMorphy’s analyses for recognizing morphological errors such as case or gender errors. DEMorphy is an off-the-shelf FST-based German morphological analyzer implemented in native Python. For reducing the set of possible analyses for one token, we use PoS tags of the original and the corrected tokens and the case information of the corrected tokens obtained from the dependency tree. The dependency tree is also used for identifying subject-verb agreement errors.

In Gerrant, an edit is checked for the different error types one after the other. First, the prefix is assigned, then the error type in accordance with the prefix. Insertion and deletion errors can only be classified as either a PoS error or a punctuation error. Edits with the prefix `S:` (Substitution) can be further classified by comparing not only the PoS but also morphological properties of the words on each side. Additionally, the edit has to be checked for spelling, orthographic, morphological and punctuation errors. Punctuation and orthographic errors are checked before PoS errors, spelling and morphological errors are checked for afterwards. The checks are all capsuled in different functions, which makes it easy to adjust the checks if need be.

For some error tags, it is sufficient to check if certain properties hold, e.g., for an orthography error `S:ORTH`, we only need to check whether case and/or whitespace is different between the words. For categories such as `DET`, there can be different readings for a word due to ambiguities: When processing a substitution error, we take all readings of the original token and all readings of the correction, try to narrow them down e.g. by case information from the dependency parse, and compare them pair-wise. For each pair, we combine all the differences with “..” (e.g. `CASE_NUM`) and collect the differences for all pairs in one set. Then, we take the minimal subsets of this set and combine them with “…” (or). This way, we end up with minimal diagnoses of the difference between the two tokens. The complete rule set can be found on Gerrant’s website.

At this point, Gerrant only works on the ComiGS Corpus and the Falko corpus. The original text and the target hypotheses were already aligned in both corpora. In the Falko data, edits were already labeled with CHA (change), INS

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3https://spacy.io/
4https://github.com/LeonieWeissweiler/CISTEM
5https://github.com/DuyguA/DEMorphy

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8A minimal subset of a set $S$ is a subset for which no other subset of $S$ is also a subset.

9https://nats.gitlab.io/gerrant

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(insertion), DEL (deletion), MERGE, SPLIT and MOVS/MOVT (move source and move target). In the ComiGS corpus, the tokens are aligned and tokens which have been moved are labeled with a tokmovid.

For both corpora, we implemented individual readers converting them to the same edit format, which is passed to the error classifier. To make Gerrant accessible for other corpora, new readers can be added, that convert input data to an edit format that is processable by Gerrant. The edit format contains the original token, its absolute position in the text (optional), its position in the sentence, the error category, the corrected token, its absolute position in the text (optional), its position in the sentence and edit type.

5 Evaluation and Discussion

To evaluate Gerrant, we (the authors) manually rated the tags for 200 randomly chosen edits independently. One half was from the ComiGS corpus, the other from the FalkoEssayL2v2.4 corpus. For each of these sets, one half was from the minimal target hypothesis and one was from the extended target hypothesis.

The raters were given the original sentence, the corrected sentence, the edit and the tag assigned by the system. The raters were asked to judge on a 4-point Likert scale how appropriate the error tag is. Since there can be multiple tags for one coarse tag (combined with “;”) and multiple parts combined in one tag (combined with “.”) and we wanted to give partial credit for partially correct tags, the rating should be given as follows:

**Strongly agree** When the error in the text matches the error type in the description of the error tag exactly and no other tag fits better. If there are multiple tags combined with “;”, every one of them fits exactly. Example 1: If S:DET:NUM_CASE is the best fitting tag and Gerrant assigns exactly S:DET:NUM_CASE. Example 2: If Gerrant assigns S:DET:CASE:GEN and both S:DET:CASE and S:DET:GEN fit exactly.

**Agree** When Gerrant assigns one error type (without combinations of parts with “;”) and the error matches the type but another error type fits better. Or: When Gerrant assigns a combination of error types (combinations of parts with “;”) and the error matches one of the assigned error types in the description of the error tag, which include the best fitting label. Example: If S:DET:NUM_CASE is the best fitting tag and Gerrant assigns S:DET:NUM_CASE:GEN.

**Disagree** When the error matches the error type in the description of the error tag without the context. Considering the sentence context, the tag is incorrect. Or: If more than one tag was assigned, no label fits perfectly, but parts of the label are correct (e.g. if the assigned tag is S:NOUN:CASE_NUM, but it is only a S:NOUN:NUM).

**Strongly disagree** When the error does not match the error type described in the error tag description. If more than one error tag is assigned, not even partial tags fit.

If none of the above cases apply, the most appropriate rating should be chosen.

In addition to the precise error tags, the raters also evaluated the coarse error tags for the same edits. The coarse error tag consists of the prefix and the first part of the error tag, e.g. S:NOUN or S:MORPH. The coarse tag for all word order errors is S:WO even if the word error’s precise tag classifies the error further as in S:WO:NOUN:CASE.

The evaluation results for both raters are shown in Table 3. When averaging over both annotators, Gerrant assigns the best or close to best fitting pre-
cise tag in 92.75% of the cases (coarse tag: 95.5%, see ). While there is only a small difference between coarse and precise tags if “strongly agree” and “agree” are considered in sum, there is a considerable drop in “strongly agree” (−12 percentage points on average) and a considerable increase in “agree” (+9.25 percentage points on average). This shows that Gerrant most often assigns the best fitting coarse tag but not as often also the best fitting precise tag but only the close to best. In only 3% of the cases on average, the precise error tag was considered as not fitting (disagree or strongly disagree), although the coarse tag was considered fitting (strongly agree or agree).

Both raters give the same rating for the precise tags in 91.5% of the cases (coarse tag: 95.5%) and 91% of the precise tags are rated as strongly agree or agree by both annotators.

There are a number of errors which Gerrant can improve on. Some error types do not behave as expected because Gerrant only extracts differences between the original and the correction, e.g. if the first word of a sentence is moved and the case is changed, this would be classified as an S:WO:ORTH, although technically it is not an orthographic error if the case was correct in the original text. For other error types, the rules can be further refined to match the tags more precisely: E.g. if the verb is changed by inserting the particle zu ("to"). Gerrant classifies this as a S:VERB:AVZ, although the separable verb prefix (weg) has not been changed. Currently insertions or deletions of the particle zu as a token on its own when it is not used as a separable verb prefix are classified as OTHER. It might be sensible to introduce an error category PART to cover all cases where the particle zu is deleted or inserted.

When a substitution error has more than one token on any side and the spans are not contiguous, Gerrant makes the simplifying assumption that this is always a word order error and uses S:WO as a prefix, although this might not be a word order error.

Gerrant can classify verb errors which contain more than one verb form on one side or both sides, e.g. for identifying tense errors. However, there are cases which Gerrant does not yet handle well: In the example in Table 5, the edit containing tokens 2 and 8 "anzuhalten → hält zu" ("has to stop" → "shuts") is tagged as a S:WO:VERB:AVZ error due to the differences in verb prefixes, although this should rather be modeled as a semantic and form error because anzuhalten ("to stop", an infinitive with the particle zu) was confused with zuhalten ("shut", a verb with the separable verb prefix zu).

Gerrant classifies verb errors based on the PoS of the original and the correction. Both sides must contain a verb form in order to check for verb errors. Because of this, some errors are not classified as verb errors due to the assigned PoS tags (an incorrect participle might be tagged as adjective and therefore is not treated as a verb).

Some improvements can also be made for recognizing ADJ:FORM and ADV:FORM, e.g. check if the adverb is accompanied with a particle (STTS tag: PTKA) or certain words such as mehr ("more").

Moreover, Gerrant could narrow down the assigned error tags further by taking more of the sentence context into account when disambiguating tokens.

6 Conclusions and Outlook

We presented Gerrant, an error annotation tool for German, which assigns error tags to given edits. Our evaluation shows that Gerrant chooses the most appropriate tag in the majority of cases. While the coarse tag is mostly correct, the precise tag is more often not the best fitting tag.

In future work, we plan to include more disambiguating information to further narrow down the possible error tags, currently the dependency tree is often used for disambiguating the corrected tokens but only rarely for the original tokens. Such
information might also be useful for reducing the set of analyses of the original tokens.

In addition, word order errors are assigned in certain rare cases in the ComiGS corpus (due to a simplifying assumption) where no reordering has taken place. Also, word order errors are currently only treated token-based which allows for a straightforward further classification of the error. However, groups of moved or rearranged tokens should be combined into one error, which would require that error spans for different errors can overlap.

Until now Gerrant has only been used on manually aligned corpora. It should be extended to be able to automatically align input.

Gerrant can be downloaded from https://nats.gitlab.io/gerrant.

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## A Error Types

Categories which can be combined with D: (deletion) or I: (insertion) to form a precise error tag:

| Category          | Description                  | Example                                              |
|-------------------|------------------------------|------------------------------------------------------|
| ADJ               | adjective                    | insertion or deletion of                             |
| ADV               | adverb                       |                                                      |
| CONJ:COORD        | coordinating conjunction     |                                                      |
| CONJ:SUBORD       | subordinating conjunction    |                                                      |
| DET               | determiner                   |                                                      |
| NOUN              | noun                         |                                                      |
| OTHER             | (default category)           |                                                      |
| PREP              | preposition                  |                                                      |
| PRON              | pronoun                      |                                                      |
| PUNCT             | punctuation                  |                                                      |
| VERB              | verb                         |                                                      |
| VERB:AVZ          | separable verb prefix        |                                                      |
| ADJ:FORM          | Either the token in the original sentence is not a valid form or the degree is incorrect. | Der freundlichere Mann → Der freundliche Mann |
| ADJ:INFL*         | The inflection degree (weak/strong) of the adjective in the original text is incorrect. | Ein schlafende Löwe → Ein schlafender Löwe |
| ADJ:NUM*          | The number of the adjective in the original text is incorrect. | Ungeduldiges Pferde wiehern. → Ungeduldige Pferde wiehern. |
| ADJ:CASE*         | The case of the adjective in the original text is incorrect. | Der schlafendem Löwe → Der schlafende Löwe |
| ADJ:GEN*          | The gender of the adjective in the original text is incorrect. | Die schöner Frau geht spazieren. → Die schöne Frau geht spazieren. |
| ADJ:-*            | Any adjective error other than NUM, CASE, GEN, INFL and FORM e. g. the adjective was semantically replaced by a different one. | Das freundliche Kind → Das fröhliche Kind |
| DET:NUM*          | The number of the determiner in the original text is incorrect. | Das Pferde stehen auf der Weide. → Die Pferde stehen auf der Weide. |
| DET:CASE*         | The case of the determiner in the original text is incorrect. | Ich gebe den Hund den Ball. → Ich gebe dem Hund den Ball. |
| DET:GEN*          | The gender of the determiner in the original text is incorrect. | Das Hund bellt. → Der Hund bellt. |
| DET:DEF*          | The definiteness of the determiner in the original text is incorrect. | Ein Hund bellt. → Der Hund bellt. |
| PRON:NUM*         | The number of the pronoun in the original text is incorrect. | Er gingen nach Hause. → Sie gingen nach Hause. |
| PRON:CASE*        | The case of the pronoun in the original text is incorrect. | Er gab mir seiner Jacke. → Er gab mir seine Jacke. |
| PRON:GEN*         | The gender of the pronoun in the original text is incorrect. | Er läuft. → Sie läuft. |
| Category | Description | Example |
|----------|-------------|---------|
| PRON:*  | Any pronoun error other than NUM, CASE or GEN. | * Er rennt. → Wer rennt? |
| NOUN:CASE* | The case of the noun in the original text is incorrect. | * Ich sehe das Auto des Mann. → Ich sehe das Auto des Mannes. |
| NOUN:NUM* | The number of the noun in the original text is incorrect. | * Die Ball rollen. → Die Bälle rollen. |
| NOUN:* | Any noun error other than CASE or NUM e.g. the noun was semantically replaced by a different one. | * Das Kalb schlief. → Das Fohlen schlief. |
| VERB:INFL | The verb is not a valid form. | * Die Vögel fliegten. → Die Vögel fliegen. |
| VERB:AVZ | The separable verb affix is incorrect in the original sentence | * Er beibringt seinem Sohn etwas. → Er bringt seinem Sohn etwas bei. |
| VERB:FORM | The infinitive form is incorrect or the use of infinitive forms or participles is incorrect | * Das Kind ist lesend. → Das Kind liest. |
| VERB:SVA* | Number and/or person of the verb in the original text are incorrect. | * Das Mädchen spielen draußen. → Das Mädchen spielt draußen. |
| VERB:TENSE* | The tense of the verb in the original text is incorrect. | * Das Mädchen spielte draußen. → Das Mädchen hat gespielt. |
| VERB:MODE* | Passive or subjunctive error in the original text. | * Das Kind hat gehend nach Hause. → Das Kind rannte nach Hause. |
| VERB:* | Any verb error other than INFL, AVZ, FORM, SVA, TENSE or MODE | * Ich tanze guter als du. → Ich tanze besser als du. |
| ADV:FORM | Either the token in the original sentence is not a valid adverb form or the degree of the adverb is incorrect. | * Ich lese immer. → Ich lese gerne. |
| ADV:* | Any adverb error e.g. the adverb was semantically replaced by a different one. | * und → aber |
| CONJ:COORD | Both tokens are conjunctions for a coordinate clause. | * weil das Kind lief → während das Kind lief weil → aber |
| CONJ:SUBORD | Both tokens are conjunctions for a subordinate clause | * Ich gehe zu das Haus. → Ich gehe zum Haus. |
| CONJ:* | Any conjunction error which is neither CONJ:COORD nor CONJ:SUBORD | * zu dem Tisch → auf dem Tisch |
| CONTR | A preposition and a determiner were contracted to a preposition or a preposition was split into a preposition and a determiner. | * Er Liebe sie → Er liebt sie |
| PREP | All involved tokens are prepositions. | * hunde Korb → Hundekorb |
| PUNCT | Any punctuation error. | * . → . |
| MORPH | Morphology error: The word in the original text and the target hypothesis have the same stem but have different PoS tags. | * Er Liebe sie → Er liebt sie |
| OTHER | Default category if none of the error tags are applicable | * hunde Korb → Hundekorb |
| Category | Description | Example |
|----------|-------------|---------|
| SPELL   | Spelling error where the original lemma is unknown and has a certain similarity to the corrected token. | Weinahtcen → Weihnachten |
| WO       | Word order error | Das Haus blaue → Das blaue Haus |

Table 5: Error categories which can be combined with the prefix S: to form a precise tag. * indicates that this tag can be combined with other tags in the same coarse category, e.g. case or number as in S:ADJ:CASE:NUM or case and number as in S:ADJ:CASE,NUM. Note that “-” cannot be combined with “,” (and). WO has a special role as it can be combined with any other category in this table (see Section 3).