

12 – Automatic Language Correction

IA161 Advanced Techniques of Natural Language Processing

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Motivation

This tool can be use to find spelling , gramar or stylistic errors in english texts. just paste some text in the the box and click 'Submit to check . Additionally, their are many different dialects you can chose from. Additionally , you can hover your mouse over a error to see it's description and an useful list of posible corrections. You don ´t need to worry for your writing skills any more, improving you're text has never be more easier!

¹Source: <http://www.onlinecorrection.com/>

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Types of errors¹:

Grammar (6) Spelling (10) Other (2) Spacing (3) Typographical (2) Duplication (1)

¹Source: <http://www.onlinecorrection.com/>

- 1 Spell checking
 - Type of errors
 - Error correction
- 2 Grammar checking
 - Rule-based grammar checking
 - Statistical grammar checking
- 3 Word completion
- 4 Best results

Automatic language correction

A text with **errors**...

- is **less comprehensible**,
- looks **less professional**,
- poses problems for **machine translation**

Automatic language correction:

- **spell checking** – detect spelling errors in individual words,
- **grammar checking** – incorrect use of person, number, case or gender, improper verb government, wrong word order, etc. . .
- **word completion** – suggestion of the word currently being entered.

Spell checking

- **detecting** which words in a document are **misspelled**,
- **providing** **spelling suggestions** for incorrectly spelled words in a text,
- **correction** is the task of **substituting** the well-spelled hypotheses for misspellings,
- usually uses a **dictionary** of valid words,
- application: **word processing** and **postprocessing** **optical character recognition** [Whitelaw et al., 2009] or **speech recognition**.

Type of errors

- **Non-word errors** – the misspelled word is not a valid word in a language,
 - ▶ typographic errors – usually keyboard typing error (e.g. “teh” – “the”, “speel” – “spell”),
 - ▶ cognitive errors – caused by the writer’s misconceptions (e.g. “recieve” – “receive”, “conspiricy” – “conspiracy”),
 - ▶ phonetic errors – substituting a phonetically equivalent sequence of letters (e.g. “seperate” – “separate”).
- **Real-word errors** – sentence contains a valid word, but it is inappropriate in the context [Hladek et al., 2013].

Example

Non-word error: “I’d like a peice of cake.”

Real-word error: “I’d like a peace of cake.”

Error correction

- Consists of two steps:
 - ▶ **generation** of candidate corrections,
 - ▶ **ranking** of candidate corrections.
- **Isolated-word methods:**
 - ▶ edit distance,
 - ▶ similarity keys,
 - ▶ character n-gram-based techniques,
 - ▶ rule-based techniques,
 - ▶ probabilistic techniques,
 - ▶ neural networks [Gupta and Mathur, 2012].

Isolated-word methods I

Edit distance

- assumption – person usually makes few errors,
- **minimum** set of **operations** to transform a non-word to a dictionary word,
- operations: **insertions**, **deletions** and **substitutions**,
- useful for: correcting errors resulting from **keyboard** input.

Example

Edit distance between “kitten” and “sitting” is 3:

- | | | |
|---|------------------|-----------------------------|
| ① | kitten → sitten | substitution of “s” for “k” |
| ② | sitten → sittin | substitution of “i” for “e” |
| ③ | sittin → sitting | insertion of “g” at the end |

Isolated-word methods II

Similarity keys:

- assign a **key** to each **dictionary** word,
- compare with the **key** computed for the **non word**,
- **most similar key** is selected as suggestion.

Soundex – phonetic algorithm (English) [Holmes and McCabe, 2002]

Example

N	Represents letters
1	B, F, P, V
2	C, G, J, K, Q, S, X, Z
3	D, T
4	L
5	M, N
6	R

- ① Keep the first letter
- ② Drop occurrences of a, e, i, o, u, y, h, w
- ③ Replace letters with numbers
- ④ Merge adjacent identical numbers
- ⑤ Add zeroes to the end, or remove right-most numbers

Output: (letter, number, number, number)

key("Robert")=R163; key("Robin")=R150 – not similar
key("Smith")=S530; key("Smyth")=S530 – similar

Isolated-word methods III

Character N-gram-based techniques:

- compute similarity coefficient of two strings
- based on the number of shared n-grams

$$\delta_n(a, b) = \frac{|n\text{-grams}(a) \cap n\text{-grams}(b)|}{|n\text{-grams}(a) \cup n\text{-grams}(b)|}$$

Example

fact vs. fract

$$\begin{aligned} \text{bigrams}(\text{"fact"}) &= \{-f, fa, ac, ct, t-\} && \dots 5 \text{ bigrams} \\ \text{bigrams}(\text{"fract"}) &= \{-f, fr, ra, ac, ct, t-\} && \dots 6 \text{ bigrams} \\ \dots \cap \dots &= \{-f, ac, ct, t-\} && \dots 4 \text{ bigrams} \\ \dots \cup \dots &= \{-f, fa, fr, ra, ac, ct, t-\} && \dots 7 \text{ bigrams} \end{aligned}$$

$$\delta_2(\text{"fact"}, \text{"fract"}) = \frac{4}{7} = 0.57$$

Isolated-word methods IV

Rule-based techniques

- a set of rules for common misspellings and typographic errors,
- each rule “fixes” one kind of error
- rules are applied to out-of-vocabulary words

Probabilistic techniques

- based on statistical features of the language (corpus)
 - ▶ transition probabilities – probability that a letter is followed by another letter
 - ▶ confusion probabilities – how often a letter is mistaken or substituted for another letter

Neural networks

- several new and promising techniques
- input node = every possible n-gram in every position of a word
- output node for each word in the dictionary

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Grammar checking

Example

“That’s good to now”

“That’s good to know”

Grammar checking starts where spell checking ends



- deals with the most **difficult** and **complex** type of language errors
 - ▶ wrong word order,
 - ▶ verb tense errors,
 - ▶ subject/verb agreement,
 - ▶ punctuation errors,
 - ▶ etc...
- two main approaches
 - ▶ **rule-based methods** – time-consuming, less flexible, more precise
 - ▶ **statistical methods** – easier and faster to implement, learn from examples, less error-prone [Nazar and Renau, 2012]

Rule-based grammar checking

Testing the input text against a set of handcrafted rules

Example

rule: I + verb(3rd person, singular form)
→ incorrect verb form usage – “I has a dog”

-  advantages:
 - ▶ rules can be easily added, modified or removed
 - ▶ rule can have a corresponding extensive explanation,
 - ▶ decisions can be traced to a particular rule,
 - ▶ rules can be authored by linguists, no need of programming
-  disadvantages:
 - ▶ large amount of manual work
 - ▶ extensive rule set is needed [Mozgovoy, 2011].

Rule-based grammar checker example

LanguageTool² – open source grammar checker

- 1 plain text as input
- 2 splits text into sentences
- 3 splits sentences into words
- 4 finds part-of-speech tags for each word and its base form
walks – walk
- 5 matches the analyzed sentences against error patterns and runs rules.

²<https://languagetool.org/> [Naber, 2003]

Rule example in LanguageTool

Example

“I **thing** that's a good idea.”

```
<rule id="YOU_THING" name="Possible typo 'I/you/... thing(think)'">
  <pattern mark_from="1">
    <token regexp="yes">I|you</token>
    <token regexp="yes">thing|things</token>
  </pattern>

  <message>Did you mean <suggestion>think</suggestion> ?</message>
  <example type="correct">I <marker>think</marker> that's a good idea.</example>
</rule>
```

Statistical grammar checking

- based on analysis of **grammatically correct** POS-annotated corpus,
- build a list of POS tag sequences,
 - ▶ some sequences are very common (**determiner+adjective+noun** as in “**the old man**”)
 - ▶ others will probably not occur at all (**determiner+determiner+adjective**)
- sequences which **occur often** in the corpus are considered **correct**,
- **uncommon** sequences might be **errors**.

Google Grammar Checker

- available in Google Docs since 2019
- based on neural machine translation architecture
- trains to translate incorrect language → correct language

Google Grammar Checker

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Word completion

- reduce the number of **keystrokes**
- **suggesting** the completion of the word
- use **context information** to predict what block of characters (letters, n-grams, syllables, words, or entire phrases) a person is going to **write next**
- based on **wide-coverage** word or **language model**
- **prediction** at earliest possible point of a **character sequence** being entered [Van den Bosch, 2011]

Best results

- **Spell checking** (first suggestion):
 - ▶ English – 95 % [Brill and Moore, 2000]
 - ▶ Czech – 73 % [Richter et al., 2012]
- **Grammar checking** (various tests average):
 - ▶ English – 55 % [Nazar and Renau, 2012]
 - ▶ Czech – 40 % [Petkevič, 2014]

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