
The University Of Sheffield.

# The (Un)Suitability of Automatic Evaluation Metrics for Sentence Simplification

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# Outline

- What is Text Simplification?
- Automatic Evaluation of Sentence Simplification
- Datasets with Human Judgements on Simplicity
- Meta-Evaluation of Automatic Evaluation Metrics
- Recommendations for Automatic Evaluation

# What is Text Simplification?

# What is Text Simplification?

To modify the content and structure of a text so that it is easier to understand while preserving its main idea and as much as possible of its meaning

**Original**

Owls are the order Strigiformes, comprising 200 bird of prey species. Owls hunt mostly small mammals, insects, and other birds ~~though some species specialize in hunting fish~~.

**Simplification**

An owl is a bird. There are about 200 kinds of owls. Owls' prey may be birds, large insects (such as crickets), small reptiles (such as lizards), or small mammals (such as mice, rats, and rabbits).

- **Elaboration:** Unusual concepts are explained
- **Lexical Paraphrasing:** Uncommon words are replaced by simpler synonyms
- **Sentence Splitting:** A long sentence is divided into several smaller ones
- **Compression:** "Unimportant" information is removed

From: http://videolectures.net/esslli2011_lapata_simplification/

# What is Text Simplification useful for?

- Information Accessibility
  - Comprehension in low-ability readers (Mason and Kendall, 1978)
  - Hard-of-hearing children (Quinley et al., 1977; Robbins and Hatcher, 1981)
  - Adults suffering from aphasia (Shewan, 1985)
  - People with dyslexia (Rello et al., 2013)
  - Non-native speakers and ESL learners (Crossley et al., 2007)
- NLP Tasks
  - Parsing (Chandrasekar et al., 1996)
  - Summarisation (Siddharthan et al., 2004; Silveira and Branco, 2012)
  - Machine Translation (Štajner and Popovic, 2016)
  - …

# Simplification Scope

- **Word-Level** (a.k.a Lexical Simplification)

The cat perched on the mat. → The cat sat on the mat.

- **Sentence-Level**

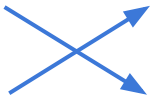
The second largest city of Russia and one of the world's major cities, St. Petersburg has played a vital role in Russian history.

→ St. Petersburg is the second biggest city in Russia.

→ St. Petersburg has played an important role in Russian history.

- **Document-Level**

(a) Facebook Chief Executive Mark Zuckerberg announced Tuesday that he plans to eventually donate 99 percent of the Facebook stock owned by him and his wife, Priscilla Chan, shares that are worth about $45 billion today.
(b) That amount would make it one of the largest philanthropic commitments ever.

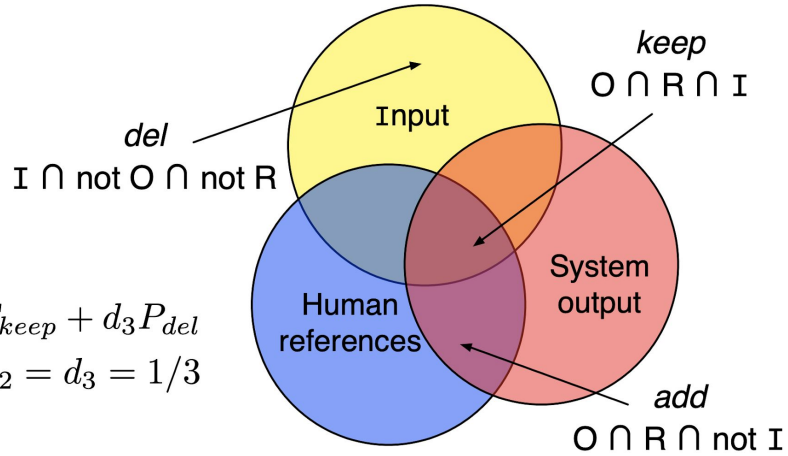


(a) Facebook Chief Executive Mark Zuckerberg announced that he and his wife, Priscilla Chan, will donate 99 percent of their Facebook stock to charity.
(b) Their promised gift would be one of the largest charitable donations ever made.
(c) Together, the couple's shares are currently worth about $45 billion.

# Automatic Evaluation of Sentence Simplification

# SARI (Xu et al., 2016)

Lexical Paraphrasing




$$\text{SARI} = d_1 F_{add} + d_2 F_{keep} + d_3 P_{del}$$
$$d_1 = d_2 = d_3 = 1/3$$

**Input:** About 95 species are currently accepted.

**REF-1:** About 95 species are currently known .
**REF-2:** About 95 species are now accepted .
**REF-3:** 95 species are now accepted .

**Output-1:** About 95 you now get in . → 0.2683
**Output-2:** About 95 species are now agreed . → 0.7594
**Output-3:** About 95 species are currently agreed. → 0.5890

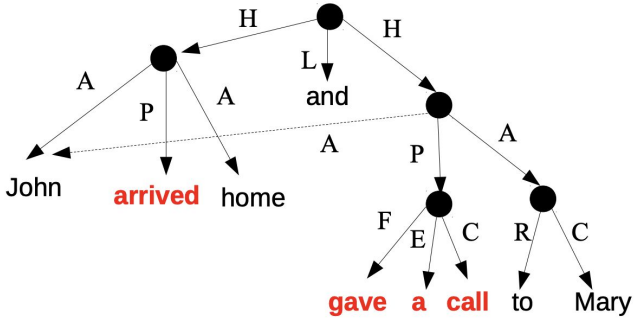
# SAMSA (Sulem et al., 2018)

Sentence Splitting

**Assumption:** In an ideal simplification each event is placed in a different sentence.

**Original Sentence:**

John arrived home and gave a call to Mary.




**System Output:**

John arrived home. John called Mary.

**Score:**
1.0

# Readability Indices

- **Flesch Reading Ease** (Flesch,1948)

$$FRE = 206.835 - 1.015\left(\frac{total\ words}{total\ sentences}\right) - 84.6\left(\frac{total\ syllables}{total\ words}\right)$$

- **Flesch-Kincaid Grade Level** (Kincaid et al., 1975)

$$FKGL = 0.39\left(\frac{total\ words}{total\ sentences}\right) + 11.8\left(\frac{total\ syllables}{total\ words}\right) - 15.59$$

# Metrics used in Machine Translation

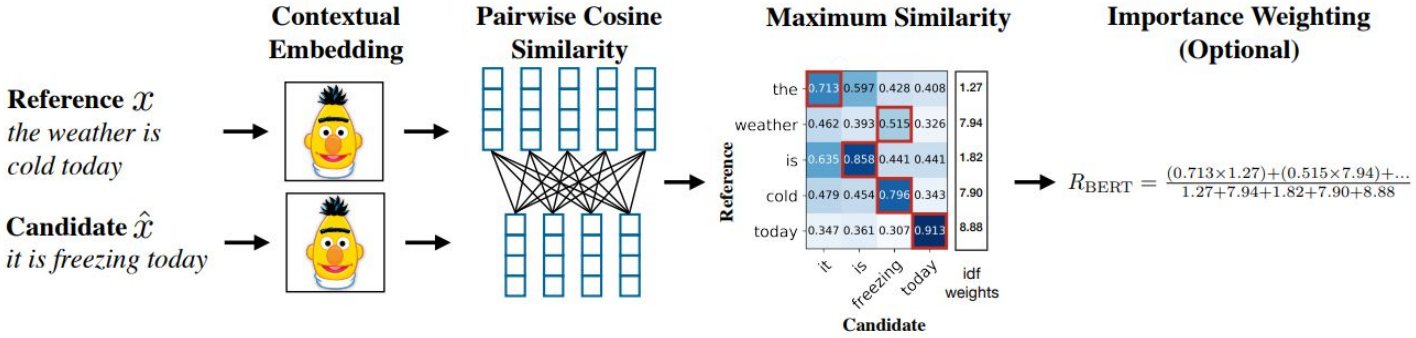
- **BLEU** (Papineni et al., 2002)

$$p_n = \frac{\sum_{S \in C} \sum_{ngram \in S} Count_{matched}(ngram)}{\sum_{S \in C} \sum_{ngram \in S} Count(ngram)}$$

$$BP = \begin{cases} 1 & if \ \ c > r \\ e^{1-\frac{r}{c}} & if \ \ c \le r \end{cases}$$

$$BLEU = BP \times exp\left(\sum_{n=1}^{N} w_n \log p_n\right)$$

- **BERTScore** (Zhang et al., 2020)

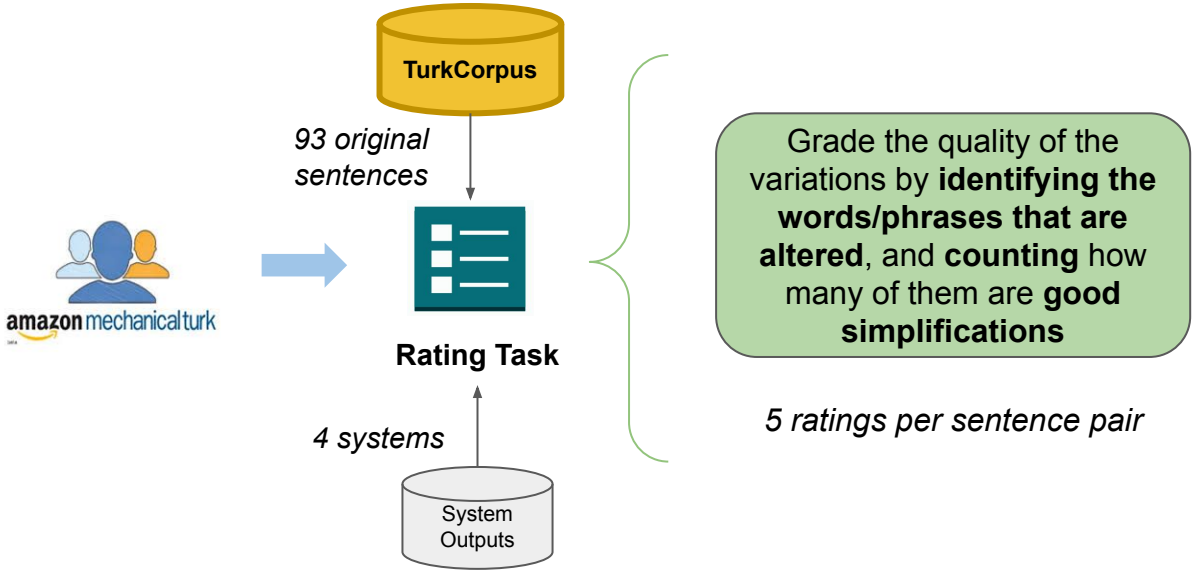


# Human Judgements on Simplicity

# Simplicity Gain

Lexical Paraphrasing

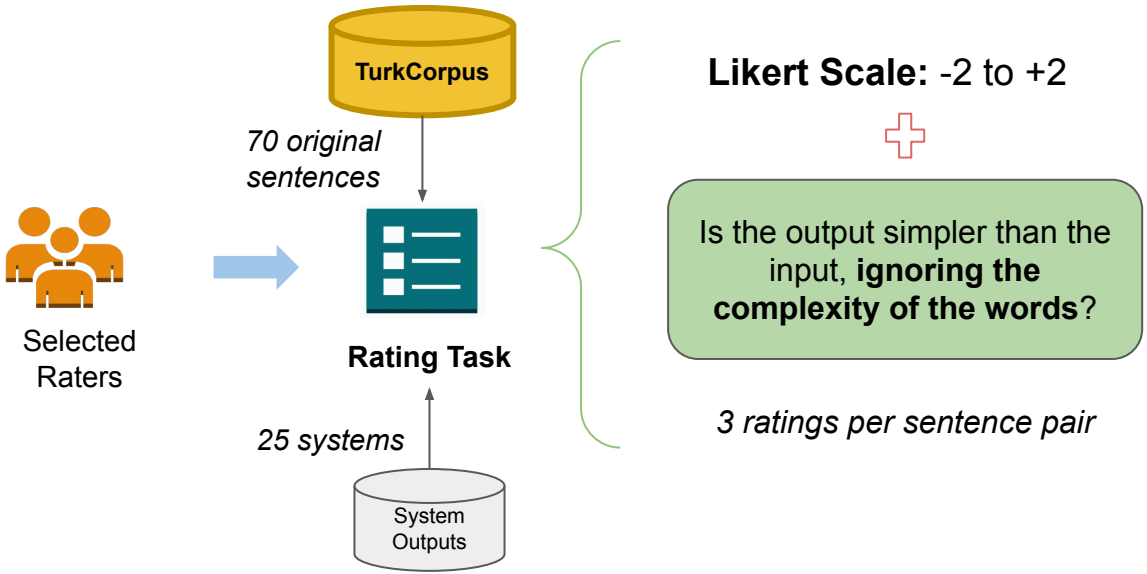
SARI



# Structural Simplicity

Sentence Splitting

SAMSA

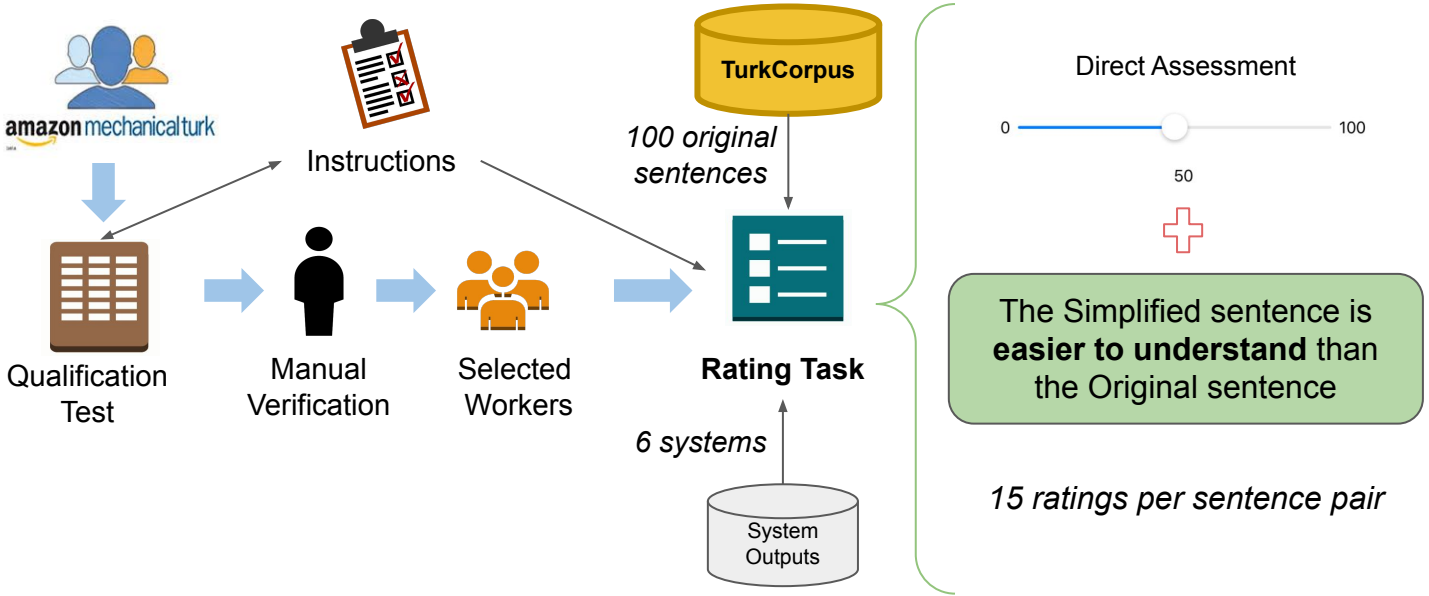


# Simplicity-DA

NEW!

General Simplicity

?



# Datasets with Human Judgements on Simplicity

| | **Simplicity Gain** (Xu et al., 2016) | **Structural Simplicity** (Sulem et al, 2018) | **Simplicity-DA** |
|---|---|---|---|
| Type of Rating | Discrete (count) | Discrete (Likert scale) | Continuous |
| Instances | 372 | 1,750 | 600 |
| System Types | PBMT<br>SBMT | PBMT<br>SBMT<br>NMT<br>Sem<br>Sem+PBMT<br>Sem+NMT | PBMT<br>SBMT<br>NMT<br>Sem+PBMT |
| ICC | 0.176 | 0.465 | 0.386 |
| Spearman's *p* | 0.299 | 0.508 | 0.607 |

Includes SotA

# Meta-Evaluation of Automatic Metrics

# Experimental Setting

- Study the behaviour of automatic metrics at the **sentence-level**
- Focused on metrics that measure (some form of) **simplicity**
- Analyse the variation of correlation w.r.t.
  a. Simplicity levels
  b. System type
  c. Set of manual references
- Metrics
  a. SARI, SAMSA, FKGL, BLEU, BERTScore
  b. Averages of BLEU, SARI, SAMSA

# Metrics across Simplicity Levels

Low scores indicate “bad” quality of a simplification, but high scores do not necessarily imply “good” quality

**Simplicity-DA**

| | Metric | Low (N = 300) | High (N=300) | All (N=600) |
|---|---|---|---|---|
| Reference-based (using ASSET) | $BERTScore_P$ | 0.512 | 0.287 | **0.617** |
| | $BERTScore_{F1}$ | 0.518 | 0.224 | 0.573 |
| | BLEU-SARI (AM) | 0.417 | 0.239 | 0.503 |
| | $BERTScore_R$ | 0.471 | 0.172 | 0.500 |
| | BLEU | 0.405 | 0.235 | 0.496 |
| | BLEU-SARI (GM) | 0.408 | 0.215 | 0.476 |
| | SARI | 0.336 | 0.139 | 0.359 |
| Non-Reference-based | FKGL | 0.272 | 0.093 | 0.117 |
| | SAMSA | 0.103 | 0.010 | 0.058 |

# BERTScore reliance on references

| | | |
|---|---|---|
| **Original** | Below are some useful links to facilitate your involvement. | **Simplicity-DA** |
| **HYP** | Below is some useful links to help with your involvement. | 0.327 |
| | **BERTScore$_P$** | |
| **REF1** | Here are good links to help you to do it. | 0.5817 |
| **REF2** | Below are some useful links to help with your involvement. | 0.9344 |
| **REF3** | Here are some useful links to help you. | 0.7308 |

References can have different degrees of simplicity

# Metrics across Simplicity Levels

Differences are not as considerable as observed for Simplicity-DA

**Simplicity Gain**

| | Metric | Low (N = 186) | High (N=186) | All (N=372) |
|---|---|---|---|---|
| Reference-based (using TurkCorpus) | $BERTScore_P$ | 0.209 | 0.231 | 0.241 |
| | $BERTScore_{F1}$ | 0.215 | 0.236 | 0.247 |
| | BLEU-SARI (AM) | 0.223 | 0.172 | 0.187 |
| | $BERTScore_R$ | 0.221 | 0.217 | 0.241 |
| | BLEU | 0.178 | 0.132 | 0.123 |
| | BLEU-SARI (GM) | 0.246 | 0.177 | 0.214 |
| | SARI | 0.292 | 0.240 | **0.331** |
| Non-Reference-based | FKGL | 0.045 | 0.101 | 0.147 |
| | SAMSA | 0.120 | 0.042 | 0.013 |

# SARI does not count correct replacements

| | | | |
|---|---|---|---|
| **Original** | Jeddah is the **principal** gateway to Mecca, Islam's holiest city, which able-bodied Muslims **are required to** visit at least once in their **lifetime**. | **Simplicity Gain** | **SARI** |
| **HYP** | Jeddah is the **main** gateway to Mecca, Islam's holiest city, which sound Muslims **must** visit at least once in **life**. | 1.83 | 0.462 |

| | | | |
|---|---|---|---|
| **Original** | The Great Dark Spot is thought to **represent** a hole in the methane cloud deck of Neptune. | **Simplicity Gain** | **SARI** |
| **HYP** | The Great Dark Spot is thought to **be** a hole in the methane cloud deck of Neptune. | 1.25 | 0.587 |

# Metrics across Simplicity Levels

BERTScore$_P$ is only the best when scoring "low" quality simplifications

**Structural Simplicity**

| | Metric | Low (N = 875) | High (N=875) | All (N=1750) |
|---|---|---|---|---|
| Reference-based (using HSplit) | BERTScore$_P$ | **0.552** | 0.310 | 0.090 |
| | BERTScore$_{F1}$ | 0.483 | 0.529 | 0.325 |
| | BLEU-SARI (AM) | 0.346 | 0.599 | 0.431 |
| | BERTScore$_R$ | 0.411 | 0.601 | 0.430 |
| | BLEU | 0.421 | **0.643** | 0.443 |
| | BLEU-SARI (GM) | 0.329 | 0.589 | 0.438 |
| | SARI | 0.137 | 0.418 | 0.313 |
| Non-Reference-based | FKGL | 0.070 | 0.165 | 0.228 |
| | SAMSA | 0.103 | 0.431 | 0.284 |

# Problems with SAMSA?

Is this score fair?

Only when splitting happens?

| | | Structural Simplicity | SAMSA |
|---|---|---|---|
| **Original** | Orton and his wife welcomed Alanna Marie Orton on July 12 2008. | | |
| **HYP** | Orton and his wife welcomed Alanna Marie Orton on July 12 2008. | 0.0 | 1.0 |

| | | Structural Simplicity | SAMSA |
|---|---|---|---|
| **Original** | Graham attended Wheaton College from 1939 to 1943, when he graduated with a BA in anthropology. | | |
| **HYP** | Graham attended Wheaton College from 1939 to 1943. He graduated with a BA in anthropology. | 0.33 | 1.0 |

Is Structural Simplicity only related to Splitting?

# Metrics across System Types

Encouraging results considering the current trend in simplification models

**Simplicity-DA**

| | Metric | SBMT (N = 100) | PBMT (N=100) | NMT (N=300) | Sem+PBMT (N=100) |
|---|---|---|---|---|---|
| Reference-based (using ASSET) | $BERTScore_P$ | 0.537 | 0.459 | **0.650** | **0.624** |
| | $BERTScore_{F1}$ | 0.528 | 0.400 | 0.588 | 0.568 |
| | BLEU-SARI (AM) | 0.315 | 0.336 | 0.536 | 0.335 |
| | $BERTScore_R$ | 0.527 | 0.375 | 0.484 | 0.470 |
| | BLEU | 0.295 | 0.347 | 0.546 | 0.333 |
| | BLEU-SARI (GM) | 0.298 | 0.320 | 0.508 | 0.308 |
| | SARI | 0.228 | 0.173 | 0.310 | 0.240 |
| Non-Reference-based | FKGL | 0.055 | 0.063 | 0.104 | 0.062 |
| | SAMSA | 0.184 | 0.067 | 0.126 | 0.248 |

# Effect of Simplification References

All metrics (but SARI) improve their correlations

**Simplicity-DA**

| | ASSET (10 references) | | | ASSET + TurkCorpus + HSplit (22 references) | | | Selected References (Different refs. per instance according to the operations performed) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Metric** | **Low** | **High** | **All** | **Low** | **High** | **All** | **Low** | **High** | **All** |
| $BERTScore_P$ | 0.512 | 0.287 | **0.617** | 0.541 | 0.280 | **0.629** | 0.543 | 0.276 | **0.635** |
| $BERTScore_{F1}$ | 0.518 | 0.224 | 0.573 | 0.530 | 0.202 | 0.576 | 0.534 | 0.202 | 0.584 |
| BLEU-SARI (AM) | 0.417 | 0.239 | 0.503 | 0.418 | 0.218 | 0.519 | 0.418 | 0.221 | 0.523 |
| $BERTScore_R$ | 0.471 | 0.172 | 0.500 | 0.476 | 0.165 | 0.506 | 0.479 | 0.165 | 0.511 |
| BLEU | 0.405 | 0.235 | 0.496 | 0.404 | 0.230 | 0.526 | 0.402 | 0.223 | 0.525 |
| BLEU-SARI (GM) | 0.408 | 0.215 | 0.476 | 0.410 | 0.195 | 0.490 | 0.410 | 0.205 | 0.496 |
| SARI | 0.336 | 0.139 | 0.359 | 0.366 | 0.097 | 0.353 | 0.352 | 0.115 | 0.350 |

# Recommendations for Automatic Evaluation

# Evaluation of Current Simplification Systems

- **Which automatic metric(s) should be used?**
  - Use multiple metrics, and mainly $\text{BERTScore}_P$
- **Which manual references should the metric(s) compare against?**
  - References in ASSET seem to be enough
- **How should the automatic scores be interpreted?**
  - First, use $\text{BERTScore}_P$ to ensure that the output is of high quality
  - Then use SARI and/or SAMSA to verify specific gains
  - However, human evaluation should be preferred for final conclusions

# Development of New Metrics

Is the way we evaluate simplicity adequate for the goals of the task?

- **Collecting More Human Judgements**
  - Simplicity-DA offers flexibility but is more subjective
  - Simplicity Gain and Structural Simplicity require more quality control
- **Combining the best characteristics of current ones**
  - Similarity based on contextual word embeddings, as in BERTScore
  - Take the input sentence into account, as in SARI and SAMSA
- **Enrich manual references**
  - Inform of the simplicity level of the references
  - Identify (manually) the operations that were performed

# Conclusion

# Contributions

- A **new dataset for evaluation of automatic metrics** following the Direct Assessment methodology
- The **first meta-evaluation** of Sentence Simplification metrics
  - Metrics can more reliably score low-quality simplifications
  - Correlations change depending on system type
  - More references does not always improve correlations
- **Recommendations for automatic evaluation** of current simplification models
- Publication
  - **Fernando Alva-Manchego**, Carolina Scarton, and Lucia Specia. On the (Un)Suitability of Automatic Evaluation Metrics in Sentence Simplification. *Computational Linguistics (under review)*.

# Thanks!

Datasets and scripts available in: https://github.com/feralvam/metaeval-simplification

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