3. Applications

Presenter: Yue

Applications

- Text Editing methods:
  - task-specific (e.g., GECToR)
  - general-purpose (e.g., LaserTagger)
  - general with task-specific modifications & tricks (e.g., Seq2Edits, PIE)

Applications

- sentence fusion
- sentence splitting & rephrasing
- text normalization
- text summarization
- machine translation automatic post-editing
- text style transfer
- incomplete utterance rewriting

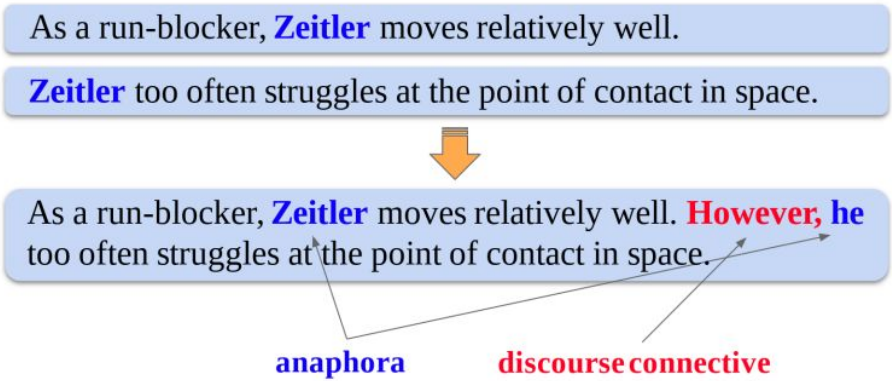
Defined briefly next

- grammatical error correction
- text simplification

Discussed in more detail

Sentence Fusion

- Joining several independent sentences into a single coherent text.



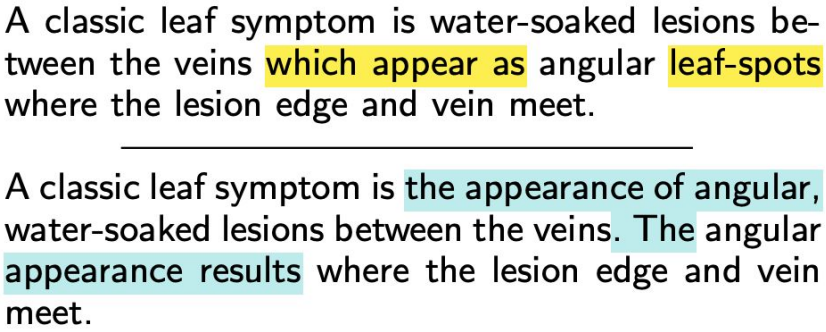
Example taken from: Geva, M. et al. (2019). *DiscoFuse: A Large-Scale Dataset for Discourse-Based Sentence Fusion* (pdf)

Barzilay, R., & McKeown, K. R. (2005). *Sentence fusion for multidocument news summarization.* (pdf)

Applications of text editing include: EdiT5, Felix, LaserTagger, Masker, Seq2Edits

Sentence Splitting

- In a sense, a reverse problem to sentence fusion
- Similar to text simplification, but lots of data available



Botha et al. (2018) Learning To Split and Rephrase From Wikipedia Edit History (pdf)

Applications of text editing include: LaserTagger

Text normalization

- Converting written text into its spoken verbalization
- spelling out numerals, currencies, phone numbers, dates, etc.

A baby giraffe is 6ft tall and weighs 150lb.

⇩

A baby giraffe is six feet tall and weighs one hundred and fifty pounds.

Sproat, R. & Jaitly, N. (2016) *RNN Approaches to Text Normalization: A Challenge* (pdf)

Applications of text editing include: Seq2Edits

Text Summarization / Compression

- See *Dernoncourt et al., 2018* (pdf) for an overview
- Earlier works on extractive summarization (Filippova et al., 2015) can be seen as predecessors of text-editing models

Summarize this for a second-grade student:

Jupiter is the fifth planet from the Sun and the largest in the Solar System. It is a gas giant with a mass one-thousandth that of the Sun, but two-and-a-half times that of all the other planets in the Solar System combined. Jupiter is one of the brightest objects visible to the naked eye in the night sky, and has been known to ancient civilizations since before recorded history. It is named after the Roman god Jupiter.[19] When viewed from Earth, Jupiter can be bright enough for its reflected light to cast visible shadows,[20] and is on average the third-brightest natural object in the night sky after the Moon and Venus.

Sample response:
Jupiter is a planet that is bigger than all the other planets in our solar system and is very bright when you see it in the night sky. It is named after the Roman god Jupiter. When viewed from Earth, it is usually one of the three brightest objects in the sky.

Text source: https://beta.openai.com/examples/default-summarize

Applications of text editing include: LaserTagger

Machine Translation Automatic Post Editing (APE)

- Task: Refine the output of an MT system

Source	Does not have a menu bar .
MT	$Weist_1$ $keine_2$ $Menüleiste_3$ $angezeigt_4$ $.5$
Reference	$Weist_1$ $keine_2$ $Menüleiste_3$ auf_4 $.5$
APE prog.	$KEEP_1$ $KEEP_2$ $KEEP_3$ auf_4 DEL_4 $KEEP_5$ $STOP$

Source: Vu, T., Haffari, G. (2018) Automatic Post-Editing of Machine Translation: A Neural Programmer-Interpreter Approach. EMNLP 2018

Applications of text editing include: Felix, LevT

Style transfer

Setting: Only non-parallel source and target examples available.

Goal: Transfer a source sentence to target style.

Example:

Source: *The best place I've visited!*
Target: *The worst place I've visited!*

Often decomposed into two subtasks:

1. Determine which words to delete
2. Determine how to replace them

Applications of text editing include: LEWIS, Masker

Incomplete Utterance Rewriting

Google AI Blog, https://ai.googleblog.com/2022/05/contextual-rephrasing-in-google.html

Task Introduction

Setting: Open-Domain Dialog between User and Agent.

Aka.: *Conversational Query Rewriting*, *Question-in-context rewriting*

Speaker	Utterance
	Why did Federer withdraw from the tournament?
	He injured his back in yesterday's match.
	Did he have any other injuries?
---	Did Federer have any other injuries besides his back?

Jin et al., *Hierarchical Context Tagging for Utterance Rewriting*, AAAI 2022 (pdf).

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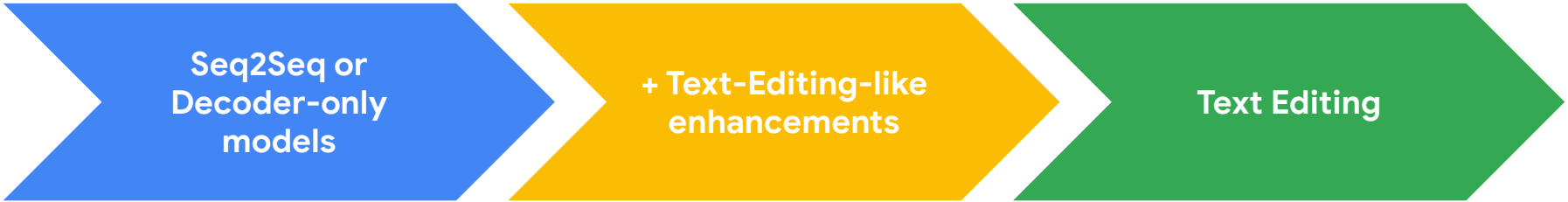
Approaches



Ren et al., WWW 2018 [pdf]

Yu et al., SIGIR 2020 [pdf]

Vakulenko et al., WSDM 2021 [pdf]

Rastogi et al., NAACL 2019 (pdf)

Su et al., ACL 2019 (pdf)

Pan et al., EMNLP 2019 (pdf)

Zhou et al., EMNLP 2019 (pdf)

Quan et al., EMNLP 2019 (pdf)

Liu et al., EMNLP 2019 (pdf)

Liu et al., EMNLP 2020 (pdf)

Huang et al., AAAI 2021 (pdf)

Hao et al., EMNLP 2021 (pdf)

Jin et al., AAAI 2022 (pdf)

Zhang et al., ICASSP 2022 (pdf)

3-1. Grammatical Error Correction

Grammatical Error Correction Task

Source: *She no drives to market.*

Target: *She did ~~no~~ not ~~drives~~ drive to market.*

Text Editing for Grammatical Error Correction

- Text Editing for GEC has picked up in the **last couple of years**
- Competitive or **SOTA results** on public benchmarks (CoNLL-14, BEA-19)
- Main highlight: ~10x **inference speedup**
- Allows for task-specific modifications

Applications of text editing include: EdiT5, Felix, GECToR, LaserTagger, PIE, Seq2Edits

Custom edit operations for GEC

- suffix transformations

PIE [1] uses a total of
58 suffix transformations

ADDSUFFIX(s):	play → play**s**
CHANGE-d-TO-t:	spend → spen**t**

  - help the model generalize
  - learned from the data

[1] Awasthi A. et al. (2019) *Parallel iterative edit models for local sequence transduction.*

Custom edit operations for GEC

- higher-level operations

GECToR [2] introduces
29 "g-transformations"

VERB_FORM_VB_VBZ:	make → make**s**
CASE_LOWER:	Medical → **m**edical
MERGE_HYPHEN:	in depth → in**-**depth

  - help the model generalize
  - implementation relies on linguistic resources (e.g., verb conjugation dictionary)

[2] Omelianchuk K. et al. (2020) *GECToR--grammatical error correction: tag, not rewrite.*

Custom edit operations for GEC

- character transformations, e.g.:

Straka et al. [3]

REPLACE_3RD_FROM_END_WITH_v: leafes → lea**v**es

  - learned from the data

[3] Straka M. et al. (2021). *Character Transformations for Non-Autoregressive GEC Tagging.*

Predicting error types

- Seq2Edits:
  - additionally predicts the **type** of grammatical error.
    - task-specific error types (ERRANT [4])
      (25 main error types: spelling, punctuation, noun inflection, verb form, etc.)

	Model size	Tags	Tuning	Pre-training	Grammar (BEA-dev) P↑	R↑	$F_{0.5}$ ↑
a	Base				23.3	11.0	19.0
b	Base	✓			22.5	13.3	19.8
c	Big			✓	50.1	34.4	45.9
d	Big	✓		✓	53.7	35.3	48.6
e	Big		✓	✓	49.0	38.6	46.5
f	Big	✓	✓	✓	50.9	39.1	48.0

Source: Stahlberg F. & Kumar S. (2020) *Seq2edits: Sequence transduction using span-level edit operations.*

[4] Bryant C. et al. (2017) *Automatic annotation and evaluation of error types for grammatical error correction.*

3-2. Text Simplification

Text Simplification (TS) Task

The process of transforming/rewriting a text into an **equivalent** which is **simpler** to understand by a target audience

Last year, I read the book that is authored by Jane.
[Original sentence]

Jane wrote a book.
I read it last year.
[One or several simpler sentences]

Text Simplification (TS) Task: Substitution

Multiple Operations:

1. **Word or phrase substitution**
2. Sentence splitting
3. Deletion
4. Syntactic style transfer

Last year, I read the book that is **authored** by Jane.

[Original sentence]

TS

Jane **wrote** a book.
I read it last year.

[One or several simpler sentences]

Text Simplification (TS) Task: Splitting

Multiple Operations:

1. Word or phrase substitution
2. **Sentence splitting**
3. Deletion
4. Syntactic style transfer

[S1] Last year, I read the book that is authored by Jane.

[Original sentence]

TS

[S1] Jane wrote a book.

[S2] I read it last year.

[One or several simpler sentences]

Text Simplification (TS) Task: Deletion

Multiple Operations:

1. Word or phrase substitution
2. Sentence splitting
3. **Deletion**
4. Syntactic style transfer

Last year, I read the book
that is authored by Jane.
[Original sentence]

TS

Jane wrote a book.
I read it last year.
[One or several simpler sentences]

Text Simplification (TS) Task: Style Transfer

Multiple Operations:

1. Word or phrase substitution
2. Sentence splitting
3. Deletion
4. **Syntactic style transfer**

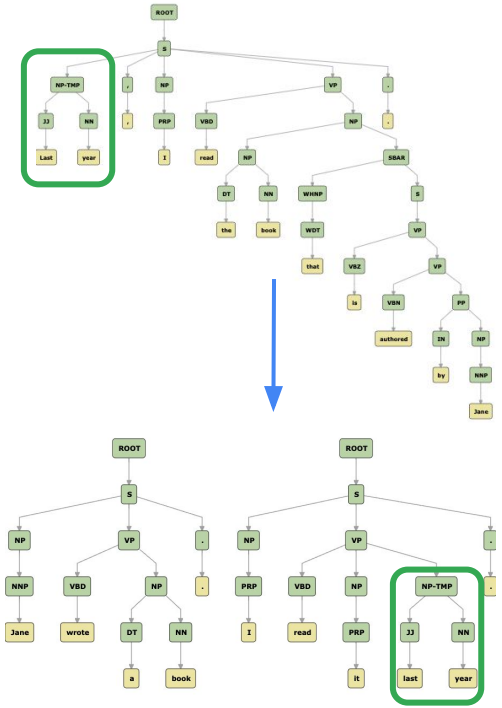
Last year, I read the book that is authored by Jane.

[Original sentence]

TS

Jane wrote a book.
I read it **last year**.

[One or several simpler sentences]



Text Editing for Text Simplification

- MT-based models have a large degree of generation freedom
- Edit-based model bounds the number of edits
  - **Controlled** generation (e.g. ratio of edits)
  - Competitive or **SOTA results** on the public benchmarks
  - Advantageous in **preserving facts** (Fact-based Text Editing, ACL 2020)
- Papers reporting on TS experiments:
  - SL (Alva-Manchego et al., 2017)
  - EditNTS (Dong et al., 2019)
  - RM (Kumar et al., 2020)
  - Felix (Mallinson et al., 2020)

Experiments for Text Simplification

Datasets
(supervised, document - summary pairs)

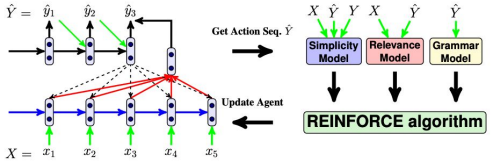
Models

WikiLarge & Small

296,402/2000/359
& 88,837/205/100

newsela

94,208/1129/1076



Baselines: e.g DRESS
(Zhang and Lapata, 2018)

DELETE (D), REPLACE (R), MOVE (M), ADD (A), REWRITE (RW)

Edit-based models

Evaluation:

- SARI (Xu et al., 2016): Measure similarity to both input and reference sentence
- Human judges rate based on fluency, adequacy, simplicity (a five-point Likert scale)

SL: Sequence Labeling (2017)

Features:

- First neural edit-based model on simplification
- Heavily rely on heuristics and other modules for operations

Five operations:

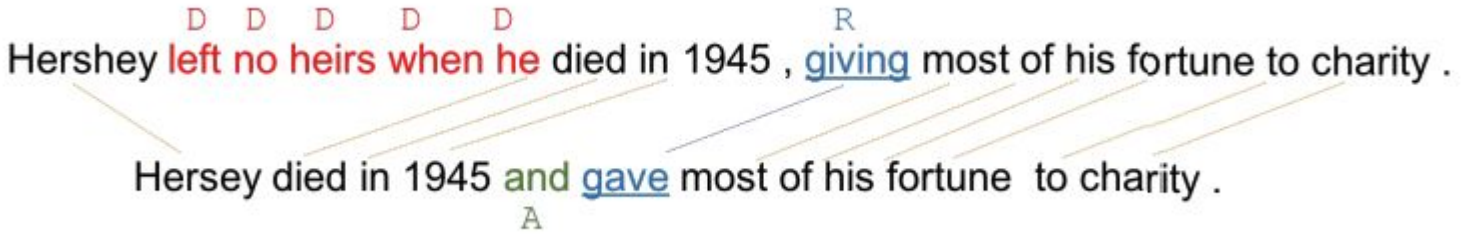
- On original sentence: DELETE (D), REPLACE (R), MOVE (M)
- ADD (A) in the simplified sentence
- REWRITE (RW)

Alva-Manchego el al., Learning How to Simplify From Explicit Labeling of Complex-Simplified Text Pairs. IJCNLP (2017)

SL Data Construction

Word alignments:

- between the original (x) and simplified sentences (y)
- DELETE : in x, not in y
- REPLACE: in x and y, but different
- ADD (A): in y, not in x

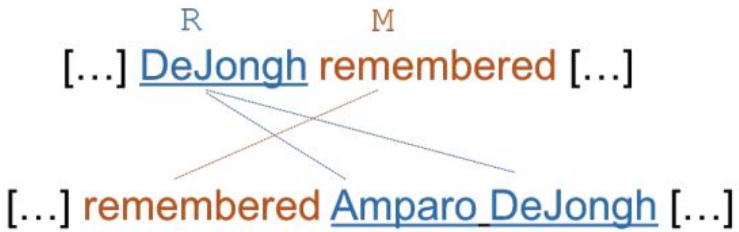


Alva-Manchego et al., 2017

SL Data Construction (Cont.)

In addition:

- REWRITE (RW): special cases of REPLACE (1-N, N-1…)
- MOVE (M): cross align



Alva-Manchego et al., 2017

Train the model on these **silver labels:**

DELETE (D), REPLACE (R), MOVE (M), ADD (A), REWRITE (RW)

SL Inference

1. Predict operation:
   - DELETE (D), REPLACE (R), MOVE (M), ADD (A), REWRITE (RW)
2. Only consider two operations DELETE (D), REPLACE (R)
   - DELETE (D): Directly delete
   - REPLACE: External Simplification Dictionary [Paetzold and Specia (2017)]

	G	M	S
Reference	5.00±0.0	4.45±0.9	2.70±1.3
SL	4.16±1.0	3.91±1.1	1.66±0.9
Nematus	4.49±0.9	3.99±1.2	1.46±0.9
Moses	4.98±0.2	4.99±0.1	1.14±0.4
NTS	4.75±0.6	4.08±1.26	1.53±1.0
Fleiss' Kappa	0.372	0.457	0.342

Alva-Manchego et al., 2017

Newsela:

Promising human evaluation (higher = better):

- Grammaticality (G)
- Meaning preservation (M)
- Simplicity (S)

Better than NTS (seq2seq) in Simplicity (S)

EditNTS Training (2019)

End-to-end neural model:

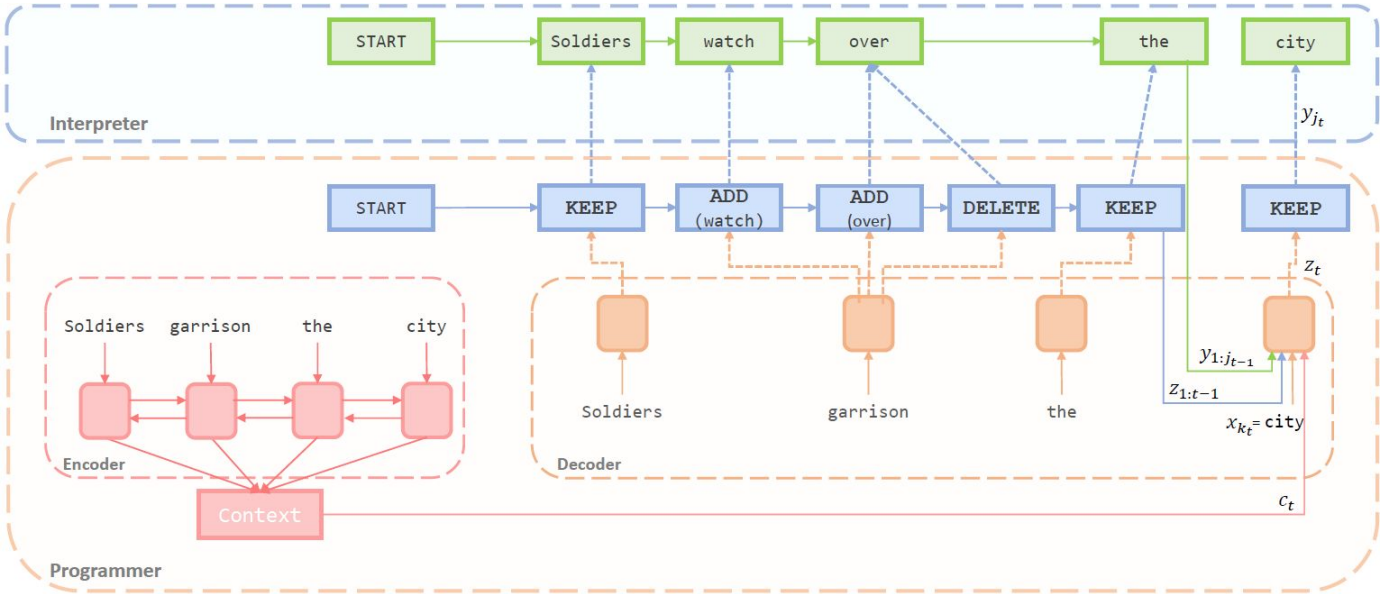
1. Create edit labels explicitly:
   - through three types of edits (z): ADD, DEL, and KEEP
2. New training objective function
   - learn p(z|x)

Dong el al., [EditNTS: An Neural Programmer-Interpreter Model for Sentence Simplification through Explicit Editing.](#) ACL (2019)

EditNTS: NPI for Modeling p(z|x)

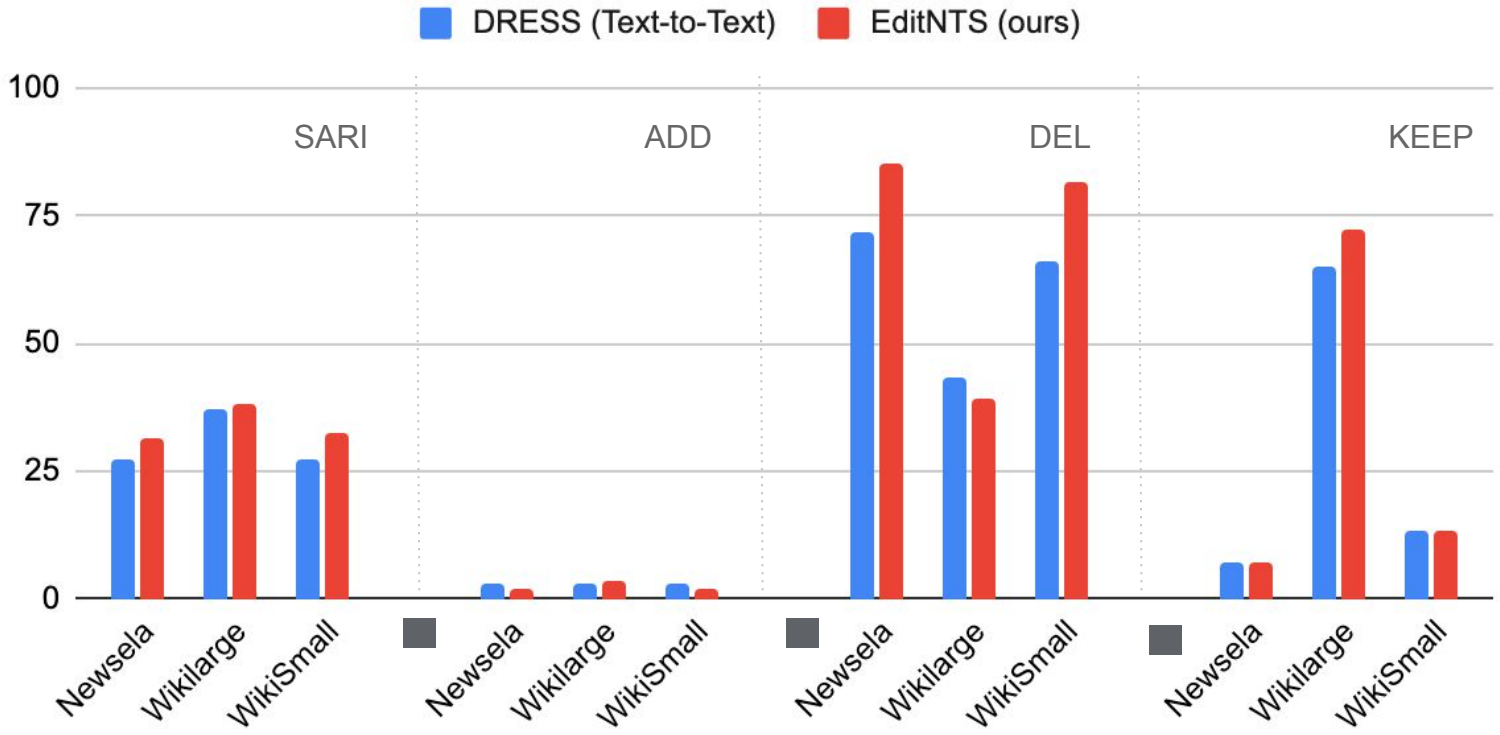
A neural programmer-interpreter (NPI)

$$P(\mathbf{z}|\mathbf{x}) = \prod_{t=1}^{\mathbf{z}} P(z_t|y_{1:j_{t-1}}, z_{1:t-1}, x_{k_t}, \mathbf{x})$$



Dong el al., [EditNTS: An Neural Programmer-Interpreter Model for Sentence Simplification through Explicit Editing.](#) ACL (2019)

EditNTS: Results



Benefits #1: Fact preserving by KEEP

Benefits #2: Controlled text generation by edit cost

Dong el al., ACL (2019)

Iterative Editing (2020)

- Four edit types:
  1. Removal
  2. Extraction
  3. Reordering
  4. Substitution

Optimize scores:

$$f(s) = f_{\text{eslor}}(s)^{\alpha} \cdot f_{\text{fre}}(s)^{\beta} \cdot (1/f_{\text{len}}(s))^{\gamma} \cdot f_{\text{entity}}(s)^{\delta} \cdot f_{\cos}(s) \quad (2)$$

In 2016 alone, American developers had spent 12 billion dollars on constructing theme parks, ***according to a Seattle based reporter***.

Deletion ↓

In 2016 alone, American developers had spent 12 billion dollars on constructing theme parks.

Reordering ↓

American developers had spent 12 billion dollars ***in 2016 alone*** on constructing theme parks.

Lexical Simplification ↓

American developers had spent 12 billion dollars in 2016 alone on ***building*** theme parks.

Kumar el al., Iterative Edit-Based Unsupervised Sentence Simplification, ACL (2020)

Iterative Editing: Score Function

Optimize score **f(s)**:

LM: fluency while preserve rare words

The Flesch Reading Ease (FRE): simplicity

Length: shorter sentences are better

$$f(s) = f_{\text{eslor}}(s)^{\alpha} \cdot f_{\text{fre}}(s)^{\beta} \cdot (1/f_{\text{len}}(s))^{\gamma} \cdot f_{\text{entity}}(s)^{\delta} \cdot f_{\cos}(s)$$

Entity Score: entity preserving

Cosine Similarity to the input sentence**: content preserving**

Iterative Editing: Unsupervised Learning

Learning if edited sentence has higher score f(s):

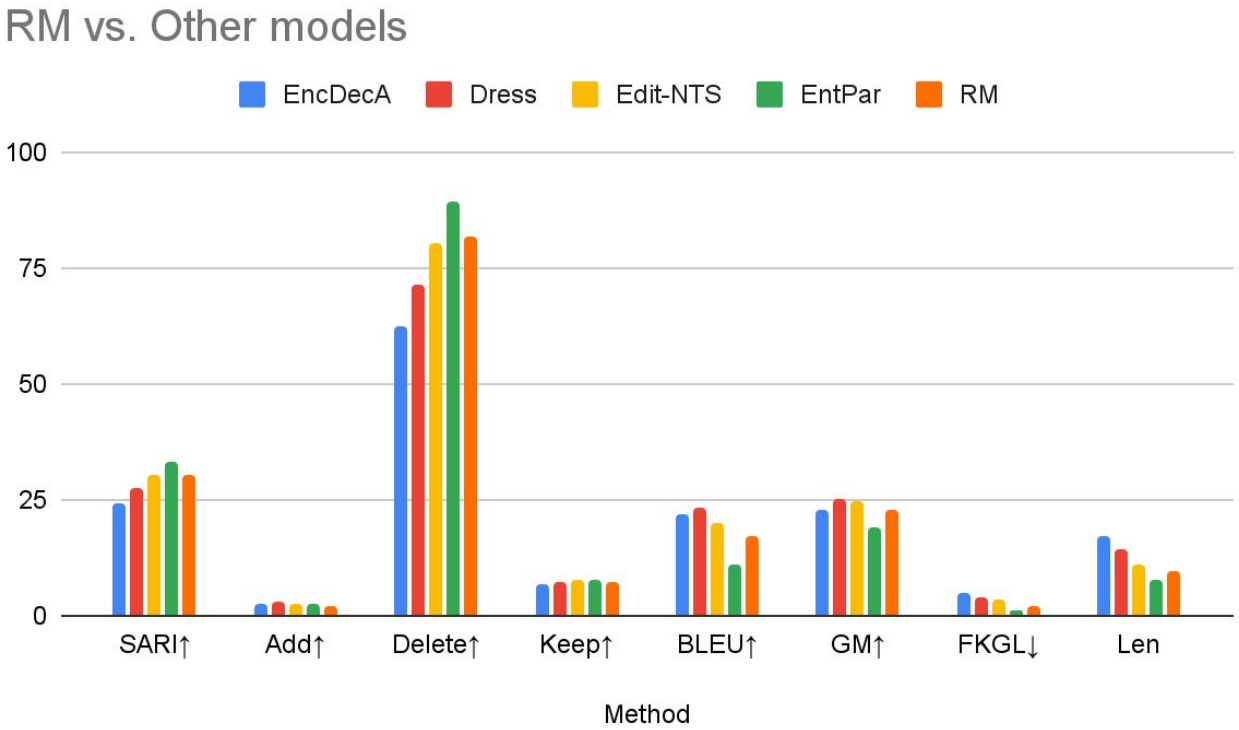
$$f(c)/f(s) > r_{\text{op}}$$

s: sentence given by the previous iteration

c: candidate generated by operator **op** from s

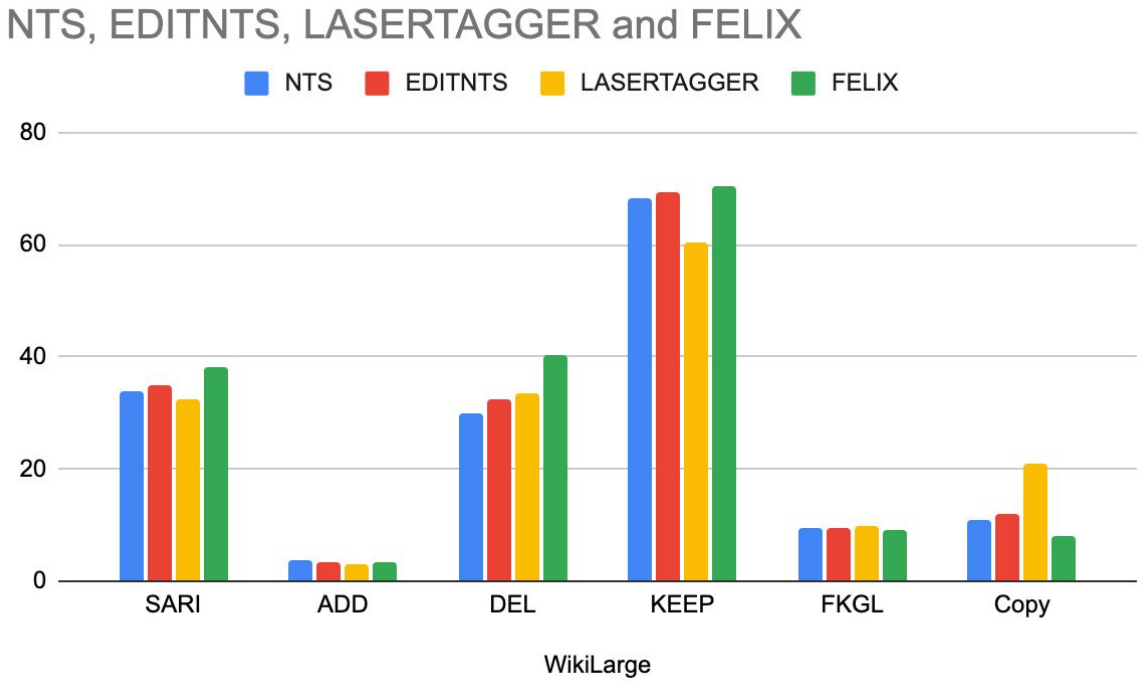
r: thresholds. different thresholds for each operation.

Results: Newsela



Based on results in [Kumar et al., 2020]

Felix: Results



Based on results in [Mallinson et al., 2020]

Questions?