Automatic Text Simplification and Linguistic Complexity Measurements

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What is Text Simplification

We are twelve billion light years from the edge,
That’s a guess,
No-one can ever say it’s true,
But I know that I will always be with you.

- Katie Melua
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We are 13.7 billion light-years from the edge of the observable universe,
That’s a good estimate,
With well-defined error bars,
And with the available information, I predict that I will always be with you.

- Simon Singh
Text Simplification and Complexity

- Aims to make information/meaning more accessible through reformulation
- I.e. to reduce linguistic complexity, targeting for instance:
Text Simplification and Complexity

- Aims to make information/meaning more accessible through reformulation
- I.e. to reduce linguistic complexity, targeting for instance:
  - Lexis
    - The words in the text reflect the difficulty of the topic
    - Replace difficult words with simpler synonyms
    - Replace technical jargon with definitions
Text Simplification and Complexity

- Aims to make information/meaning more accessible through reformulation
- I.e. to reduce linguistic complexity, targeting for instance:
  - Lexis
  - Syntax
    - Longer sentences with embedded clauses are more difficult to read than shorter sentences
    - Split complicated multi-clause sentences into simpler ones
Text Simplification and Complexity

- Aims to make information/meaning more accessible through reformulation
- I.e. to reduce linguistic complexity, targeting for instance:
  - Lexis
  - Syntax
  - Text Length
    - Longer texts require readers to have more stamina and a greater capacity to remember details
    - Reduce text length by deleting peripheral information
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  - Texts with key information repeated in different ways is more likely to result in retention of information
  - Increase text length by adding redundancy (through reformulation, analogy, metaphor, examples...)

Simple Language

Automatic Text Simplification

Evaluating Simplified Texts
Text Simplification and Complexity

- Aims to make information/meaning more accessible through reformulation
- I.e. to reduce linguistic complexity, targeting for instance:
  - Lexis
  - Syntax
  - Text Length
  - Discourse
    - Chronological or cause/effect ordering of sentences is easier to follow than more sophisticated structures - stories within stories, flashbacks, parallel plots, etc.
  - Reorder information to simplify argumentation
Text Simplification and Complexity

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- I.e. to reduce linguistic complexity, targeting for instance:
  - Lexis
  - Syntax
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  - Discourse
  - **Cohesive texts are easier to follow**
  - Make content more transparent by making discourse relations explicit
Text Simplification and Complexity

- Aims to make information/meaning more accessible through reformulation
- I.e. to reduce linguistic complexity, targeting for instance:
  - Lexis
  - Syntax
  - Text Length
  - Discourse
  - Semantics
  - The readers’ background knowledge affects their ability to read and comprehend texts
  - Conceptual simplification
  - Numerical simplification
  - Simplify meaning
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- I.e. to reduce linguistic complexity, targeting for instance:
  - Lexis
  - Syntax
  - Text Length
  - Discourse
  - Semantics
  - Quality
    - Errorful text is harder to read
    - Check spelling and grammar
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- I.e. to reduce linguistic complexity, targeting for instance:
  - Lexis
  - Syntax
  - Text Length
  - Discourse
  - Semantics
  - Quality
    - More engaging text is easier to read
    - Paint a picture (use visual words)
    - Personal narratives
    - Humour
Manual Text Simplification

- Explored extensively with regard to (typically, middle) school performance
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  - Anderson & Davison (1988) and Irwin (1980): Specific information orderings were found to facilitate readers with poorer reading ability
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- Similar results have been found for readers with low levels of domain expertise Noordman & Vonk (1992); Kamalski et al. (2008); McNamara et al. (1996).
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- Similar results have been found for L2 (Long & Ross, 1993; Yano et al., 1994; Tweissi, 1998; Gardner & Hansen, 2007)
Some criticisms of text simplification

Honeyfield (1977); Long & Ross (1993); Yano et al. (1994); Oh (2001):

- Can impede language acquisition
- Homogenises vocabulary across the text, and makes important information harder to identify
- Simplified texts are not interesting
- Not really simpler (e.g. use of readability formulae as guides to writing)
System Complexity $\rightarrow$ Text Complexity

- System Complexity is an (unstatistical) property

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  - Monolingual Translation
  - Same “system”, different probabilities
My recent work on Automatic Text Simplification

The original police inquiry, which led to Mulcaire being jailed in 2007, also discovered evidence that he has successfully intercepted voicemail messages belonging to Rebekah Brooks, who was editor of the Sun when Mulcaire was working exclusively for its Sunday stablemate.
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- Syntactic Simplification (Siddharthan, 2010, 2011):
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Lexical Simplification (Siddharthan & Angrosh, 2014):

The first police inquiry led to Mulcaire being jailed in 2007. The police enquiry also found proof that he has successfully intercepted voicemail messages belonging to Rebekah Brooks. Rebekah Brooks was editor of the Sun. Mulcaire was working only for its Sunday stablemate then.
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Sentence Compression (Angrosh et al., 2014):

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ATS and complexity

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ATSS and complexity

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  - These assume error-free text
  - ATS struggles to produce error-free text
  - Evaluations focus on correctness of operations, and (sometimes) impact on comprehension
Example of simplified language

- Motherese: The language adults use to talk to children
  (Cross, 1977; Papoušek et al., 1987; Gleitman et al., 1984)
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  - Lexical:
    - reduced vocabulary
    - reduction in the number of verb inflections
    - replacement of pronouns with names
Example of simplified language

- Motherese: The language adults use to talk to children (Cross, 1977; Papoušek et al., 1987; Gleitman et al., 1984)
  - Syntactic:
    - reduction of pre-verb length and complexity
    - reduction in the number of embedded clauses and conjunctions
    - shortening of utterance lengths
    - reduction in the number of disfluencies and fragments
Example of simplified language

- Motherese: The language adults use to talk to children (Cross, 1977; Papoušek et al., 1987; Gleitman et al., 1984)
  - Speech: slowing of speech rate
Example of simplified language

- Motherese: The language adults use to talk to children (Cross, 1977; Papoušek et al., 1987; Gleitman et al., 1984)
  - Similar observations for bilingual accommodation (e.g., Giles et al., 1973)
Controlled language

- Controlled Language: interest from industries in creating better (less ambiguous and easier to translate) user manuals (O’Brien, 2003)
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  - Lexical:
    - Rule out use of particular acronyms, synonyms, pronouns and ambiguous anaphoric reference, double negations
    - Insist on inclusion of relative pronoun
    - Standardise format for numbers and dates
    - Specify dictionary, rule out ambiguous words.
Controlled language

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  - Syntactic:
    - rule out ellipsis
    - insist on use of article or demonstrative
    - restrict size of noun cluster
    - specify location of prepositions to reduce ambiguity
    - rule out passive voice, insist on indicative mood
    - specify use of punctuation
Controlled language

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  - Textual Structure:
    - specify when lists or tables should be used
    - constrain maximum sentence and paragraph lengths
    - specify keywords to use for coherence
    - restrict use of parentheticals.
Controlled language

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  - Pragmatic:
    - rule out use of metaphor, slang or idiom
    - urge author to be as specific as possible
Target reader populations

- Deaf readers
  (Quigley & Paul, 1984; Marschark & Spencer, 2010)
  - infrequent words, coordination, subordination, pronominalisation, passive voice and relative clauses...
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- **Dyslexic readers**
  (Vellutino et al., 2004; Ramus, 2003)
  - infrequent and long words...
ATS for target reader populations

- Deaf readers (Daelemans et al., 2004)
- Aphasic readers (Carroll et al., 1998)
- Children (De Belder & Moens, 2010)
- Low Literacy Adults (Specia, 2010)
- L2 learners (Petersen, 2007)
- Dyslexic readers (Rello et al., 2013)
Challenges for ATS (and complexity?)

- Simplify through elaboration or use of analogy/metaphor
  - Ubiquitous in science texts for children: “The cell as a marketplace”, etc.
  - Also emphasised by L2 community
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- ATS: How?
Challenges for ATS (and complexity?)

- Simplify through elaboration or use of analogy/metaphor
  - Ubiquitous in science texts for children: “The cell as a marketplace”, etc.
  - Also emphasised by L2 community
- ATS: How?
- Complexity: Can complexity/readability measures capture this?
Challenges for ATS (and complexity?)

- Be unambiguous and specific
  - Emphasized by Controle Language prescriptions
  - But, simpler / more frequent words have more senses
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    - In a pilot study, readers showed a preference for less polysemous (but also less frequent) words (Walker et al., 2011)
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  - **Complexity:** Can complexity/readability measures capture ambiguity effects?
Early Motivations for ATS
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- Reduce linguistic complexity as a pre-processing step for a parser (Chandrasekar & Srinivas, 1997)
  - learnt syntactic rules from aligned parse trees aimed to produce shorter sentences so parsers didn’t time out as often
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  - applied synchronous grammars to simplification
  - used ILP for optimising output characteristics
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  - explored lexical simplification and pronoun replacement
- Study coherence issues (Siddharthan, 2003)
  - detected and fixed disfluencies by modelling attentional state and intentional structure
Modelling Complexity

Early systems:

- **Syntax**: typically considered relative clauses, conjunction and (sometimes) passive voice
- **Lexis**: used resources such as Oxford Psycholinguistic Database (Quinlan, 1992) to measure lexical difficulty
Recent Work

- **Text Simplification as Machine Translation**
Recent Work

- **Text Simplification as Machine Translation**
  - Does not model complexity directly, but learns mappings between constructs in the two genres
  - Parallel corpora do not really exist at this scale for other languages, but manual analysis of small parallel corpora can inform ATS: Portuguese (Aluísio et al., 2008); French (Brouwers et al., 2014)
Recent Work

- Text Simplification as Machine Translation
  - Phrase Based Machine Translation
    (Specia, 2010; Wubben et al., 2012; Coster & Kauchak, 2011):
      - Map word sequences: Do not attempt syntactic simplification
Recent Work

- Text Simplification as Machine Translation
  - Syntax based Machine Translation
    (Zhu et al., 2010)
    - Does not attempt lexical simplification
    - Does not handle morphology, but can reorder, delete or substitute constituents
Recent Work

- Text Simplification as Machine Translation
  - Quasi-Synchronous Tree Substitution Grammars (Woodsend & Lapata, 2011)
    - Lexical: Can perform word substitutions, but no method for modelling lexical context for preserving word senses
    - Syntactic: Does not handle morphology, but can reorder, delete or substitute constituents
Recent Work

- Text Simplification as Machine Translation
  - Hybrid Systems
    (Narayan & Gardent, 2014)
    - PBMT for lexical rules
    - Syntactic rules using DRT representations
Recent Work

- **Text Simplification as Machine Translation**
  - Hybrid systems
  - (Siddharthan & Angros, 2014)
    - Uses handwritten linguistically sound rules for syntactic simplification
    - Uses Synchronous Dependency Grammars for lexicalised constructs
Lexical Simplification
Lexical Simplification

- Lexical Substitution
  - Identify difficult words
    - typically using some frequency-based metric
    - but need to be clever for compounding languages (hjärteko)
  - Identify easier lexical substitutions where possible, and filter/rank these using a context vector or Word Sense Disambiguation
  - Where no lexical substitutions exist, use definitions of words
Lexical Simplification

- Technical terms often do not have easier synonyms
- Explanations can be constructed using ontology relations (e.g., MESH) (Zeng-Treitler et al., 2007; Kandula et al., 2010)
  - “Pulmonary atresia” is simplified as “Pulmonary atresia (a type of birth defect)”
- Definition can be obtained with “Google define:”
  - “Pulmonary atresia” is defined as “Pulmonary atresia is a form of heart disease that occurs from birth (congenital heart disease), in which the pulmonary valve does not form properly.”
ATS for different languages

- Basque (Aranzabe et al., 2012)
- Bulgarian (Lozanova et al., 2013)
- Danish (Klerke & Søgaard, 2013)
- Dutch (Daelemans et al., 2004)
- English (De Belder Moens, 2010 ... Narayan Gardent, 2014)
- French (Seretan, 2012; Brouwers et al., 2014)
- Italian (Barlacchi & Tonelli, 2013)
- Japanese (Inui et al., 2003)
- Korean (Chung et al., 2013)
- Portuguese (Aluísio et al., 2008; Watanabe et al., 2009)
- Spanish (Bott et al., 2012)
- Swedish (Smith & Jönsson, 2011; Abrahamsson et al., 2014)
In general, development of complexity measures and simplification systems lags behind English for other languages.

PITR: Workshop on Predicting and Improving Text Readability

- Last year, lots of submissions from compounding languages and morphologically rich languages
- Approaches for English often can’t be used off the shelf
Evaluating Text Simplification

- *How good does automatic text simplification need to be?*
  - The typical target reader of a text simplification system has poor reading skills.
  - Errorful system output might be unusable, even when it could be understood by a fluent reader.
Evaluating Text Simplification

- *How are text simplification systems evaluated?*
  - Few ATS studies to date with target reader populations
  - Evaluations of fluency and correctness have been on a small scale
  - Not clear how useful text simplification systems really are.
Evaluating Text Simplification

How are text simplification systems evaluated?

Automated evaluations:

- Compare system output to manually simplified text (BLEU or NIST scores) (Coster & Kauchak, 2011)
- Intrinsic Readability scores (Louis & Nenkova, 2013)
- None of these account properly for errors that increase comprehension difficulty, or for unintentional meaning change.
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Ratings by fluent readers:

- Fluency, Simplicity, Meaning (Siddharthan, 2006; Wubben et al., 2012; Woodsend & Lapata, 2011)
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Online Methods:

- Eye-tracking: Fixation times etc. (Bott et al., 2012)
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  - Online Methods:
    - Eye-tracking: Fixation times etc. (Bott et al., 2012)
  - Offline Methods for recall / comprehension:
    - Cloze tests (Jonnalagadda et al., 2009)
    - Sentence Recall (Siddharthan & Katsos, 2012)
    - MCQs (Canning, 2002; Angrosh et al., 2014)
Questions for Complexity metrics

- All simplification systems result in shorter sentences and simpler words
  - Can complexity metrics distinguish these systems?
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- Can/should complexity metrics quantify fluency as well as simplicity?
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- Can complexity metrics correlate with comprehension data?
**Example of errorful system output 1**

**EW:** Four generations of the Willis family continued the family tradition of organ building until 1997 when Henry Willis 4 retired, and the first non-family Managing Director was appointed.

- Siddharthan & Angrosh (2014):
  - Four generations of the Willis family continued the family tradition of organ building until 1997.
  - At that time, Henry Willis 4 retired.
  - And the first non-family Managing Director was given.

- **SEW:**
  - Four generations of the Willis family continued the family tradition of organ building until 1997, when Henry Willis the fourth retired and the new Managing Director of the firm was not a member of the Willis family.
Example of errorful system output 2

**EW:** The music may be performed by a single musician, sometimes then called a recital, or by a musical ensemble, such as an orchestra, a choir, or a musical band.

- Siddharthan & Angrosh (2014):
  - The music may did a single musician, normally then named a recital, or a musical ensemble, such as an orchestra, or a choir, or a musical band.

- **SEW:**
  - A concert given by just one performer (or perhaps two) is usually called a recital.
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- ATS could potentially use complexity metrics to achieve different degrees of simplification.
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- ATS needs automated metrics for evaluation.
- ATS could potentially use complexity metrics to achieve different degrees of simplification.
- Perhaps complexity research needs a challenge too?
References


Seretan, V. 2012. Acquisition of Syntactic Simplification Rules for French. LREC.


