Manipulating the Difficulty of C-Tests

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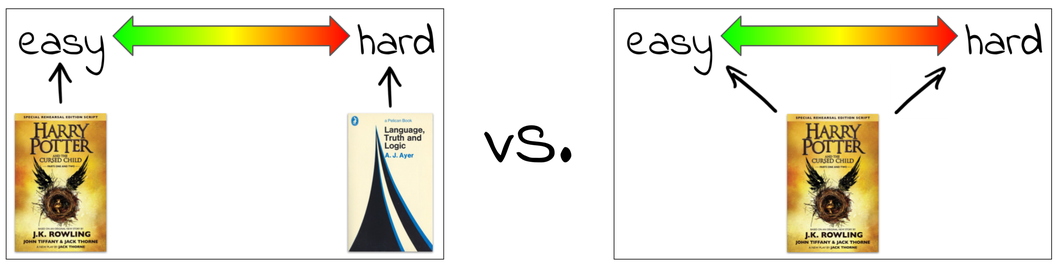
1 Motivation

How to automatically generate exercises of different target difficulty from a single text?

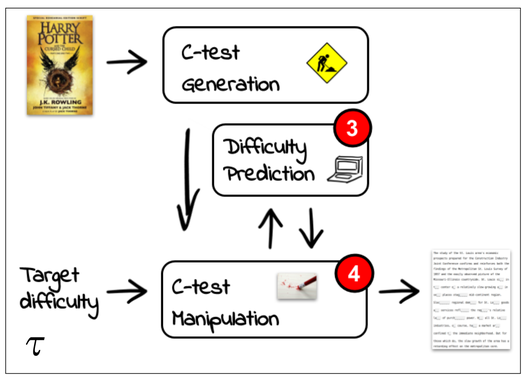


Static approach — Proposed approach

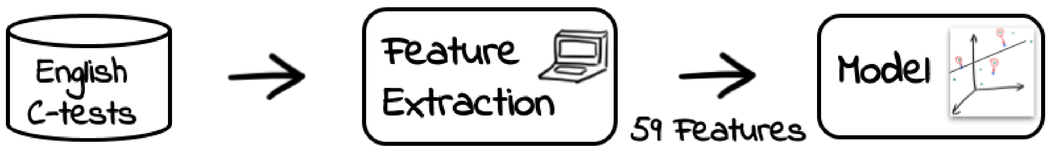
- Language learning requires a lot of effort and motivation
- Personalized exercises can help keeping learners motivated
- For example, using their favorite book as a basis for exercises

2 Overall Architecture

1. Create standard C-Test
2. Assess difficulty
3. Manipulate C-Test
4. Go to *2.* **if not**
   a) Reached target difficulty τ
   b) No manipulation possible
5. **Return** resulting C-Test



3 C-Test Difficulty Prediction



- Reproduction study of the work done by Lisa Beinborn (2016)
- Seemingly small changes may lead to different results (e.g., using a newer system dictionary)
- Achieved similar performance as the original system

	Original data			New data		
Model	ρ	RMSE	qwκ	ρ	RMSE	qwκ
SVM (original)	.50	.23	.44	–	–	–
SVM (reproduced)	.49	.24	.47	.50	.21	.39
MLP	.42	.25	.31	.41	.22	.25
BiLSTM	.49	.24	.35	.39	.24	.27

4 C-Test Difficulty Manipulation

Algorithm 1 Gap size strategy (SIZE)

procedure IncreaseDifficulty(T, τ)
  $G_{\text{SIZE}} \leftarrow G_{\text{DEF}}$
  $D \leftarrow d(T)$
  while $D < \tau$ **do**
    $g^* = (i, \ell) \leftarrow \arg\max_{g \in G_{\text{SIZE}}} \Delta_{\text{inc}}(g)$
    $\ell \leftarrow \ell + 1$
    $D \leftarrow D + \Delta_{\text{inc}}(g)$
  return G_{SIZE}

Algorithm 2 Gap selection strategy (SEL)

procedure GapSelection(T, τ)
  $G_{\text{FULL}} \leftarrow \{(i, \lceil \frac{|w_i|}{2} \rceil) \mid 1 \le i \le 2n\}$
  $G_{\text{SEL}} \leftarrow \emptyset$
  while $|G_{\text{SEL}}| < n$ **do**
    $G_{\le\tau} \leftarrow \{g \in G_{\text{FULL}} \mid d(g) \le \tau\}$
    if $|G_{\le\tau}| > 0$ **then**
      $g^* \leftarrow \arg\min_{g \in G_{\le\tau}} |d(g) - \tau|$
      $G_{\text{SEL}} \leftarrow G_{\text{SEL}} \cup \{g^*\}$
      $G_{\text{FULL}} \leftarrow G_{\text{FULL}} \setminus \{g^*\}$
    $G_{>\tau} \leftarrow \{g \in G_{\text{FULL}} \mid d(g) > \tau\}$
    if $|G_{>\tau}| > 0$ **then**
      $g^* \leftarrow \arg\min_{g \in G_{>\tau}} |d(g) - \tau|$
      $G_{\text{SEL}} \leftarrow G_{\text{SEL}} \cup \{g^*\}$
      $G_{\text{FULL}} \leftarrow G_{\text{FULL}} \setminus \{g^*\}$
  return G_{SEL}

- SIZE: Modifying the gap size
  - Keep the initial gaps G_{DEF}
  - Only change the gap size ℓ
  - Increase (decrease) gap size for higher (lower) C-Test difficulty Δ_{inc} (Δ_{dec})
- SEL: Changing the gap selection
  - Create all possible gaps G_{FULL}
  - Select gaps closest to target difficulty

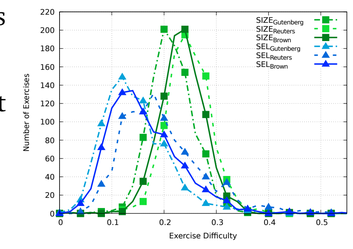
What are C-Tests?

C-Tests are fill-the-gap exercises where the second half of a word is turned into a gap for every second word in a text. To provide some contextual information, the first and the last sentence of a text do not contain any gaps. Due to the first half remaining as a hint, C-Tests have less ambiguity but still require orthographic, morphologic, syntactic, and semantic competencies.

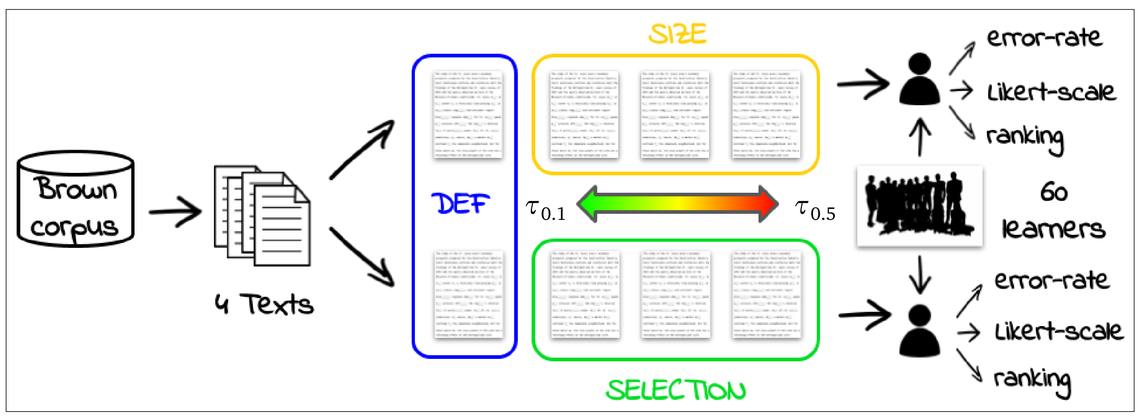
> St. Louis si__ in t__ center o_ a relatively slow-growing a__ in so__ places stag____ mid-continent region . Slac_____ regional dem___ for St. Lo___ goods a__ services refl____ the reg___'s relative la__ of purch_____ power. N__ all St. Lo___ industries, o_ course, ha__ a market ar__ confined t_ the immediate neighborhood.

5 Evaluation of Achievable Target Difficulty

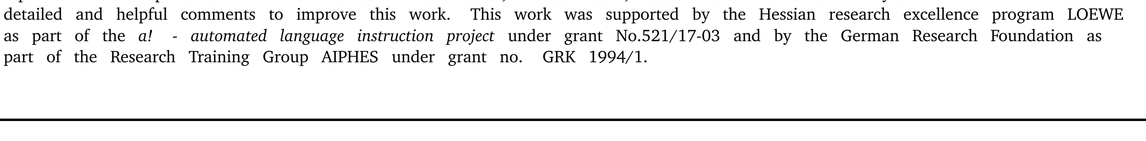
- Automatic evaluation on the Gutenberg, Reuters, and Brown corpus
- Assess influence of the underlying text for a target difficulty τ
- Create maximally ($\tau_{\max} = 1.0$) and minimally ($\tau_{\min} = 0.0$) difficult C-Tests and estimate their difficulty using SEL and SIZE
- Most texts produce C-Tests with $\tau \in [0.0, 0.4]$
- Error-rate ranges $\tau_{\max} - \tau_{\min}$ for different corpora



6 User Study for C-Tests of Different Target Difficulties



- Sample four texts $\{T_1, T_2, T_3, T_4\}$ of medium difficulty from the Brown corpus
- Use T_1 as the reference C-Test (same for all participants)
- For $\{T_2, T_3, T_4\}$, create an easy ($\tau = 0.1$), hard ($\tau = 0.5$), and default version with SEL and SIZE.
- Two groups of 30 participants each solve either SEL or SIZE modified C-Tests.
- Each participant solves four C-Tests and provides feedback on a five-point Likert-scale, their error-rate, and by ranking all C-Tests according to their perceived difficulty.



a) Error-rate — b) Likert-scale — c) Ranking

7 Conclusion

- Both manipulation strategies were able to create C-Tests of a target difficulty τ and were also perceived accordingly
- This allows us to create language learning exercises from a learner-preferred basis of texts to keep them motivated
- Work towards personalized learning process for different learners

Code and Data

https://github.com/UKPLab/acl2019-ctest-difficulty-manipulation

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