Dmesure : a readability formula for French as a foreign language

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2. What is readability?
3. Methodological steps
4. Evaluation
5. Perspectives for future research
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The sector of foreign language teaching is growing and changing:

- There is a will to optimize the costs of education while improving its quality.
- The number of professionals is insufficient relative to demand.
- Learners want more flexibility in teaching methods (timetable, place...).

ICALL has been viewed as a solution to these issues through the development of self-learning software.
Contribution of ICALL

- For teachers, ICTs provide access to authentic language and real communication situation:
  - Automatic retrieval of texts on the web
  - Allow interaction with people from other cultures

- ICTs also help relieve teachers of repetitive tasks:
  - Automated design of exercises aimed at the assimilation of specific linguistic forms (such as collocation, grammar notion...) through repetition.
Two kind of applications

Automated design of exercises based on a corpus

- French: **ALEXIA** [Chanier and Selva, 2000]; **ALFALEX** [Selva, 2002, Verlinde et al., 2003]; **MIRTO** [Antoniadis and Ponton, 2004, Antoniadis et al., 2005].
- English: **Cloze tests** [Coniam, 1997, Brown et al., 2005]; **WERTi** [Amaral et al., 2006]; **VISL** [Bick, 2001]

Web crawlers for the automatic retrieval of web texts on a specific topic and at a specific readability level

- French: ?
- English: **IR4LL** [Ott, 2009]; **REAP** [Heilman et al., 2008b], **READ-X** [Miltsakaki and Troutt, 2008]
Generation of exercises: an example

**ALFALEX**

[Selva, 2002, Verlinde et al., 2003]

- Automated design of exercises on morphology, gender, collocations...
- Difficulty of the task: 2 levels
- Difficulty of the context is not controlled! It depends on the level of the corpus used.
An example of this contextual complexity

**Exercice de morphologie**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>La forme à compléter est nécessairement différente du mot donné en fin de phrase.</td>
<td></td>
</tr>
<tr>
<td>ATTENTION : le numéro de phrases disponibles est limité à 30. Si vous souhaitez faire des exercices supplémentaires sur la morphologie (avec d’autres exemples), voir FAQ sur la page d’accueil.</td>
<td></td>
</tr>
</tbody>
</table>

1. Il faut choisir la bonne, une musique instrumentale, et non des airs capiteux. 
   {doux}

2. *Aufland de la petite poste rénovée sont venus s’ajouter la mairie, l’office de tourisme, un secrétariat mutualisé, l’école, un médecin et un dentiste, demain une pompe à essence, s’enthousiasme Brigitte Fargueville. 
   {maternel}

3. Sa {capain} préfère parler de "l’ambiance incroyable" qui régnait dans le cabaret. 

4. La rude vie du petit séminaire, les copains, la découverte et les longues discussions avec une jeune novice lui ouvrent les {oeil} sur l’incertitude de sa vocation. 
   {malin}

5. Mais le couple le plus attachant est celui qui réunit un grand Black bourré d’humour et une petite Hollandaise à croquer. 
   {oeil}

6. Opération de séduction, sans doute, mais qui reflète à l’évidence les aspirations d’une société de la {parole des ayatollahs} de la térule des ayatollahs. 
   {las}

7. Les {rugbyman} australiens ont disputé la première rencontre de leur tournée. 
   {capital}

8. Mais l’essentiel pour Singapour est de préserver son secteur des services qui représente 70% du PIB et de continuer à attirer les {capital} et le savoir-faire dans un certain nombre de secteurs-céls.
Readability model as a solution

We can control two aspects:

- Difficulty of the task: already taken into consideration (2 levels)
- Contextual difficulty using a difficulty model (see figure)
Retrieval of web texts: an example for EFL

**REAP**

[Heilman et al., 2008b, Collins-Thompson and Callan, 2004]

- REAeding-specific Practice aims at improving reading comprehension abilities through practice.
- It integrates a SVM thematic classifier.
- Difficulty is checked using the readability formulas described in [Collins-Thompson and Callan, 2005, Heilman et al., 2008a]
- [http://reap.cs.cmu.edu/](http://reap.cs.cmu.edu/)
Readability: an example

**Grammar-based Reading Difficulty Prediction**

**Grade level predicted: 12.0**

Accuracy generally improves with text length. The software will provide estimates for texts of any length, but a minimum length of 30 words is recommended. Also, the system is generally more accurate for grade levels above 2.

Type or paste your text into the box below and press "Submit" to obtain an estimate of the difficulty of your text.

A narrow grave-yard in the heart of a bustling, indifferent city, seen from the windows of a gloomy-looking inn, is at no time an object of enlivening suggestion; and the spectacle is not at its best when the mouldy tombstones and funeral umbrage have received the ineffectual refreshment of a dull, moist snow-fall. If, while the air is thickened by this frosty drizzle, the calendar should happen to indicate that the blessed vernal season is already six weeks old, it will be admitted that no depressing influence is absent from the scene.

An estimation of the readability of the first lines of *The Europeans* (H.James). It has been assessed by the model of [Heilman et al., 2007].

Url: http://boston.lti.cs.cmu.edu/demos/readability/index.php
Beyond search engines, there is no tool available for FFL.

**Situation actuelle**

Recherche Internet

Résultats

Professeur,… cherche un texte sur un sujet donné.

Zzzz !
Why a difficulty model would be interesting

Amélioration

Résultats

Web, corpus

Requête

Professeur,…

Modèle de Difficulté

Textes sélectionnés
Difficulty model : a definition

Strictly speaking, a model for contextual difficulty in FFL:

1. Amounts to assess the **reading** complexity of a text fragment for a FFL learner
   - What is reading in a foreign language?
   - What good is it to read when learning a L2?

2. It is an issue better known as readability.
   - What is a readability formula?
   - What previous work exist?
   - What should be the characteristics of a readability formula specific to L2 reading?
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Definitions

Readability can be defined as:

*The sum total (including the interactions) of all those elements within a given piece of printed material that affect the success of a group of readers have with it. The success is the extent to which they understand it, read it at a optimal speed, and find it interesting.* [Dale and Chall, 1949, 1]

*Par lisibilité, nous désignons le degré de difficulté éprouvé par un lecteur essayant de comprendre un texte.* [Henry, 1975]
Conception of a formula: methodological steps

1. Collect a corpus of texts whose difficulty has been measured using a criterion such as comprehension tests or cloze tests.

2. Define a list of linguistic predictors of the difficulty, such as sentence length or lexical load.

3. Design a statistical model (traditionally linear regression) based on the above features and corpus.

4. Validate the model.

\[
Y = B_2 + A_1 + C_2 + A_2 + \ldots
\]

\[
X_{i1} = -748.7 \\
X_{i2} = 5.32 \\
\ldots \\
X_{in} = 1
\]

Prediction on a new text.
Some trends in the field

Readability is mostly a Anglo-Saxon field:

- First formulas appeared in the US: they considered only the lexicon. [Lively and Pressey, 1923, Vogel and Washburne, 1928]
- Classic formulae: they are based on linear regression and only 2 predictors (one lexical, one syntactic) [Flesch, 1948, Dale and Chall, 1948]
- The revolution of the cloze test: more complex formulae appeared as well as the first computational efforts. [Smith and Senter, 1967, Bormuth, 1966, Bormuth, 1969]
- The cognitive area corresponds to a critique of the classical formulae, unable take into consideration some more semantic aspects (coherence, cohesion...)[Kintsch and Vipond, 1979, Kemper, 1983]
Situation for French

There are few studies about French L1:

- Some formulae for English were used with small adjustments [Kandel and Moles, 1958, de Landsheere, 1963]
- A few specific formulae for French L1 were coined [Henry, 1975, Richaudeau, 1979, Mesnager, 1989]

There are even fewer about FFL:

- Previous work: [Cornaire, 1985, Uitdenbogerd, 2005]
- Our first model: [François, 2009a, François, 2009b]

Conclusion

There is indeed a real need for such a model.
How to improve the existing

Using NLP and Data Mining techniques

- Provides a better coverage for the formula, since the corpus is bigger
- New statistical algorithm should better model the relations between difficulty and text characteristics
- NLP tools allow to model more complex variables, such as semantic ones, that could not be taken into consideration into previous automated formulae

Building on theoretical contributions from cognitive psychology

- Studies aiming at defining the reading process may help discovering new difficulty predictors
- Others focusing on the distinction between L1 and L2 reading help developing a model specific to L2 reading
- Reading studies make apparent the limitations of readability formulae
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4. Validate the model.

\[
Y = B_2 + A_1 t_1 + A_2 t_2 + C_2 t_3 + \ldots
\]

\[
X_i = \begin{align*}
X_{i1} &= -748.7 \\
X_{i2} &= 5.32 \\
\vdots \\
X_{in} &= 1
\end{align*}
\]

Prediction on a new text.
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The corpus

Collecting the corpus

Goal
Collect a corpus labelled by reading-difficulty levels, which implies:
- agreement on the difficulty scale, and
- the use of a criterion to assess the level of each text.

The classic approach

- **The criterion**: tests (comprehension or cloze tests...) are applied on a population.
- **The scale of measurement**: is a quantitative one: percentages corresponding to the average achievement tests. However, they are often transformed into a grade level scale.
The corpus

My own approach

The needs

- The NLP perspective of readability requires a large number of texts
- The scale of measurement should have a practical interpretation

A solution

- Since 2001, the difficulty level of FFL textbooks has to be expressed in the “Common European Framework of Reference” scale.
- It is then possible to use FFL textbooks as a source of labelled texts.
- The difficulty-level of a text corresponds to the textbook level it comes from...
- This scale is immediately usable by FFL teachers
The CEFR scale

- It has 6 levels:
  A1 (easier), A2, B1, B2, C1, and C2 (higher)

- Some authors / teachers recommend to refine the scale by dividing certain levels:
  Then, we also used a 9-levels scale: A1 (easier), A1+, A2, A2+, B1, B1+, B2, C1, and C2 (higher)

- This division can better take into account differences in skills for learners of lower levels, where they are more pronounced than in the upper levels.
Obviously, it is not possible to use all textbooks as corpus, nor all texts.

**Criteria**

- Textbooks should be posterior to 2001
- The public target should be adults and young people.
- Textbooks for general purposes (we excluded the FFL for specific purposes textbooks)
- Inside the selected textbooks, only texts associated with a task of reading comprehension were kept
First analyses: the corpus is noisy

Why?

- In modern textbooks using the actional approach, it happens to meet a complicated text that is associated with a simpler task. Eg.: RP LM = -731 (at level A1, where the mean = -700)
- On the opposite, it happens to meet a simple text that is associated with a complex task (e.g. a song at the B2 level)
- In both cases, it seems that our assumption (level of the text = level of the textbook) may not hold.

Some solutions

- Currently, outliers are suppressed.
- We are planning to check manually for such cases.
- Creation of a less noisy corpus (using Dmesure)
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Difficult predictors

- **Lexical predictors (4):**
  - Language models (LM1, LM2, LM3)
  - Mean number of letters per word (NLM)

- **Syntactical predictors (12):**
  - Mean number of words per sentence (NMP)
  - 11 binary variables: tense and mood

- **Dialogue variables (5):**
  - They aim to determine whether the text is a dialog or not
Why a language model?

**Theoretical foundation**
Various studies in psycholinguistics suggest an association between the difficulty of words and their frequency
[Howes and Solomon, 1951, Brysbaert et al., 2000]

**The classic approach**
They use a percentage of words absent from a list of the most frequent words of the language (Thorndike’s, Dale’s or Gougenheim’s)
[Dale and Chall, 1948, Henry, 1975]

**The language model**
A smoothed unigram model may be used advantageously instead of these lists [Collins-Thompson and Callan, 2005]
**LM : which is the best token unit?**

Which is the best unit for the unigram model in French?

- lemma (LM1)
- inflected forms (LM2)
- inflected forms (LM3) disambiguated using TreeTagger [Schmid, 1994]

**Results**: The correlations with the “difficulty“ are similar

<table>
<thead>
<tr>
<th>Unit</th>
<th>LM1</th>
<th>LM2</th>
<th>LM3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation (r)</td>
<td>-0.58</td>
<td>-0.58</td>
<td>-0.59</td>
</tr>
</tbody>
</table>
Syntactical predictors

- List of 11 binary variables selected:
  - Conditional
  - Imperfect
  - Present participle
  - Subjunctive present
  - Future
  - Infinitive
  - Present
  - Subjunctive imperfect
  - Imperative
  - Past participle
  - Simple past

- **Objective**: model the pace of teaching grammar in a context of FLE

- **Optimal approach**: automatic recognition of grammatical structures

- **Problem**: syntactic parsers for French are still lacking precision and slow. Therefore, we opted for this simplified parameterization.
Difficulty factors

Dialogue variables

Assumption

Dialogues are easier to read and understand than narratives, instructional or scientific texts.

⇒ lexicon and syntactical structures are simpler; topic are closer to everyday life [Dolch, 1948, Flesch, 1948, Gunning, 1952, Henry, 1975]

Selected variables:

- Proportion of personal pronoun of dialogue (1P, 2P)
- Ratio of interjection on the number of words
- Ratio of "!" and "?" on the number of following punctuation marks (! ? .)
- Ratio of "!" and "?" on the number of these punctuation marks (! ? . ; :)
- Presence of quotation marks for dialogue
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The statistical models

Statistical models used

- **Regression models**: they depend on the type of the dependent variable
  - Continuous $\Rightarrow$ Linear regression
  - Ordinal $\Rightarrow$ Proportional odds model (PO)
  - Categorical $\Rightarrow$ Multinomial logistic regression (MLR)

- Models based on **decision trees**:
  - Classification tree (baseline) [Breiman et al., 1984]
  - Boosting [Freund and Schapire, 1996]
  - Bagging [Breiman, 1996]

- **Support Vector Machines** [Boser et al., 1992]
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Evaluation data

2 scales of measurement = 2 datasets:

- **6-levels model**: an i.i.d sample (Corp6) of 299 texts of the corpus
- **9-levels model**: an i.i.d sample (Corp9) of 449 texts of the corpus

**Outliers**

Here, an outlier is defined as an observation located more than three standard deviations away from the average of its class.

- Corp6: 11 outliers (remains 288 texts)
- Corp9: 12 outliers (remains 437 texts)
Two evaluation procedures

- **The features selection**: we used a stepwise selection based on the Akaike’s Information Criterion (AIC):

  \[ AIC = -2 \times \text{log-likelihood} + 2k \]

  where \( k \) = number of parameters in the model

- **Ten-fold cross-validation**: estimation of the model performance on new data were evaluated through 3 measures:
  - Multiple correlation coefficient (\( R \))
  - Accuracy
  - Adjacent Accuracy: proportions of predictions that were within one level of the human-assigned level for the given text [Heilman et al., 2008a]
Features selection

- Stepwise selection process is sensitive to variations of the model and training data

- Selected variables for some models:
  - Proportional odds model:
    - **Corp6**: ML1 + ML3 + NMP + PPD + PI + PPEI1 + BINGUI + Futur + Impf + Infi + PPasse + Subp
    - **Corp9**: ML3 + NMP + PPD + PPEI2 + BINGUI + Cond + Futur + Impf + Infi + PPasse + Pres + Subp
  
  - Multinomial regression model:
    - **Corp6**: ML1 + NLM + NMP + BINGUI + Futur + Impf + Infi + PasseSim
    - **Corp9**: ML2 + ML3 + NMP + PPD + PPEI1 + Cond + Futur + Impf + PPasse + Subi + Subp
Relative importance of the features

However, we often find two lexical variables and NMP: they form the basis of the formula.

Example of decomposition of the accuracy:
Comparison of the models

Results from the 10-folds cross-validation on both corpus:

![Comparison of models](image)
Other similar studies

- **On French L1:**
  - For a 5-classes problem: $R = 0.64$; Acc. and Adj. Acc. are not reported
  - [Collins-Thompson and Callan, 2005]

- **On English L1:**
  - For a 12-classes problem: $R = 0.64$ (grades 1-6) and 0.79 (grades 7-12); Acc. and Adj. Acc. are not reported
  - [Collins-Thompson and Callan, 2005]

- **On English L2:**
  - For a 12-classes problem: $R = 0.773$ (PO) and 0.582 (MLR); Adj. Acc. = 52% (PO) and 45% (MLR)
  - [Heilman et al., 2008a]
First conclusions

- It is the first specific formula for FFL that uses a NLP approach (and one of the few for FFL)
  - The corpus includes a variety of text types, ensuring a wider coverage to the formula

- The criterion used (level of the textbooks according to the CEFR scale) seems questionable: the noise in the corpus can cause a poor learning.

- Our experiments suggest the (slight) superiority of SVM and logistic regression, a technique which is less demanding than the first.

- Optimizing the statistical aspects do not seem very useful for future improvements.
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3 main lines of research

- **Statistical optimization**
  - Multilayer neural networks
  - Using reject option

- **New features**
  - Experimenting with new variables, or from the literature, either drawing on current work on the reading process

- **Reducing the noise in the corpus**
  - Using a manual exploration of the present corpus
  - Collecting a new one, whose texts have been validated by teachers and learners
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Studies about the reading process

The reading process

Reading is seen as a series of cognitive operations, here summarized as:

1. **Visual feature analysis**: the eyes move to capture the words on the page
2. **Word recognition**: activity specific to reading that is to recover the meaning of words in memory
3. **Comprehension** (share the same brain network for written and oral): information extraction from the text and integration in long-term memory

Dual-route cascade model

[Coltheart et al., 2001]
Hypothesis

The textual elements that slow or hinder these processes can be considered as sources of difficulty, such as:

- Familiarity with words: frequency or age of acquisition (= 1st appearance in FFL textbooks?)
- Imageability (more or less equivalent to the level of concreteness of words)
- Redundancy rate (TTR failure, N-gram?)
- Number of different meanings for a word (facilitating effect or not?)
- Degree of correspondence between the written and phonetic form
- ...
Differences between L1 and L2 reading

An observation

Reading processes in L1 and L2 differ. Therefore, the readability formulas should take into account these differences.

L1 reading: fluency in spoken language pre-exists

- Learn to read = develop a system of correspondences between graphemes and phonemes [Rayner et al., 2001]
- While the importance of decoding is crucial for beginners, it is understanding that prevails for the advanced reader
- Therefore, formulae based on lexical features should be more suitable for beginners, while structural or cognitive factors are better predictors for advanced learners [Chall and Dale, 1995]
## Differences between L1 and L2 reading

### L2 reading
- Reader must learn the language while they “learn” to read in L2.
- Conversely, he has already more concepts and knowledge about the world [Koda, 2005]
- There are some interferences with existing structures [Bernhardt, 2003]

### Consequences on readability
- Before a given threshold, the student is severely handicapped by his lack of language skills in L2: lexicon and syntax are predominant [Alderson, 1984]
- Beyond that threshold, he may transfer its reading skills from its L1 to its L2. Then, the importance of structural and cognitive factors increases again.
- Interferences with the mother tongue must also be considered, especially through the cognates [Laroche, 1979]
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Dmesure: a new tool for readability

Dmesure: the alpha version

Termes de recherche:


Recherche avancée

Utiliser 9 niveaux

Rechercher
Dmesure : a new tool for readability

Dmesure : 2 goals

Dmesure (stands for Difficulté Mesure) aims at the 2 following objectives:

- Provide a free tool helping FFL teachers in the use of the web as a corpus for finding teaching materials
- Provide a web 2.0 platform where teachers can participate in assessing the difficulty of texts they have collected through DMeasure and they have used in their teaching
Dmesure : a new tool for readability

Dmesure : the one-text interface

This text comes from the textbook Panorama (A2, p.159)
Dmesure: a new tool for readability

Dmesure: the one-text interface

The model did well on that one!!
Dmesure: a new tool for readability

Dmesure: web search service
Dmesure : a new tool for readability

Dmesure : web search service

Terms of search:

Difficulty of text:

Recherche avancée

Utiliser 9 niveaux

Translate the text into English:

Dmesure: a new tool for readability

Dmesure: web search service

Terms of search:

Difficulty of text:

Recherche avancée

Utiliser 9 niveaux
Dmesure: a new tool for readability

Dmesure: the teacher interface

Merci de valider les textes que vous avez lus ou testés en classe. Cela permettra d'améliorer les performances de Dmesure.
[en savoir plus : Rechercher un texte ; Valider un texte ; Annuler une validation précédente ]
Dmesure : a new tool for readability

Dmesure : the architecture

Architecture of Dmesure

Web GUI

MySQL DB

Web GUI

Yahoo BOSS

Web service

Page Downloader

REST service H. Naets

CouchDB

Filters

Readability formula
Dmesure: Some preliminary remarks

- While still needing to be debugged, the architecture seems suited to the task.
- The one-text interface already gives good results, but the web search tool gives very poor predictions.
- This is explained by the nature of text data found on the web. More work must be done on:
  - Cleaning the boilerplate
  - Checking the language correctness
  - Adaptating the readability model to this specific task (some predictors are better suited to the web environment)
Dmesure : a new tool for readability

The end

Difficulté estimée :

Votre texte :

A2

Merci pour votre attention.

Sachez que les questions et les commentaires sont les bienvenus :)
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