DEXTER: Automatic term extraction of domain-specific glossaries for language teaching

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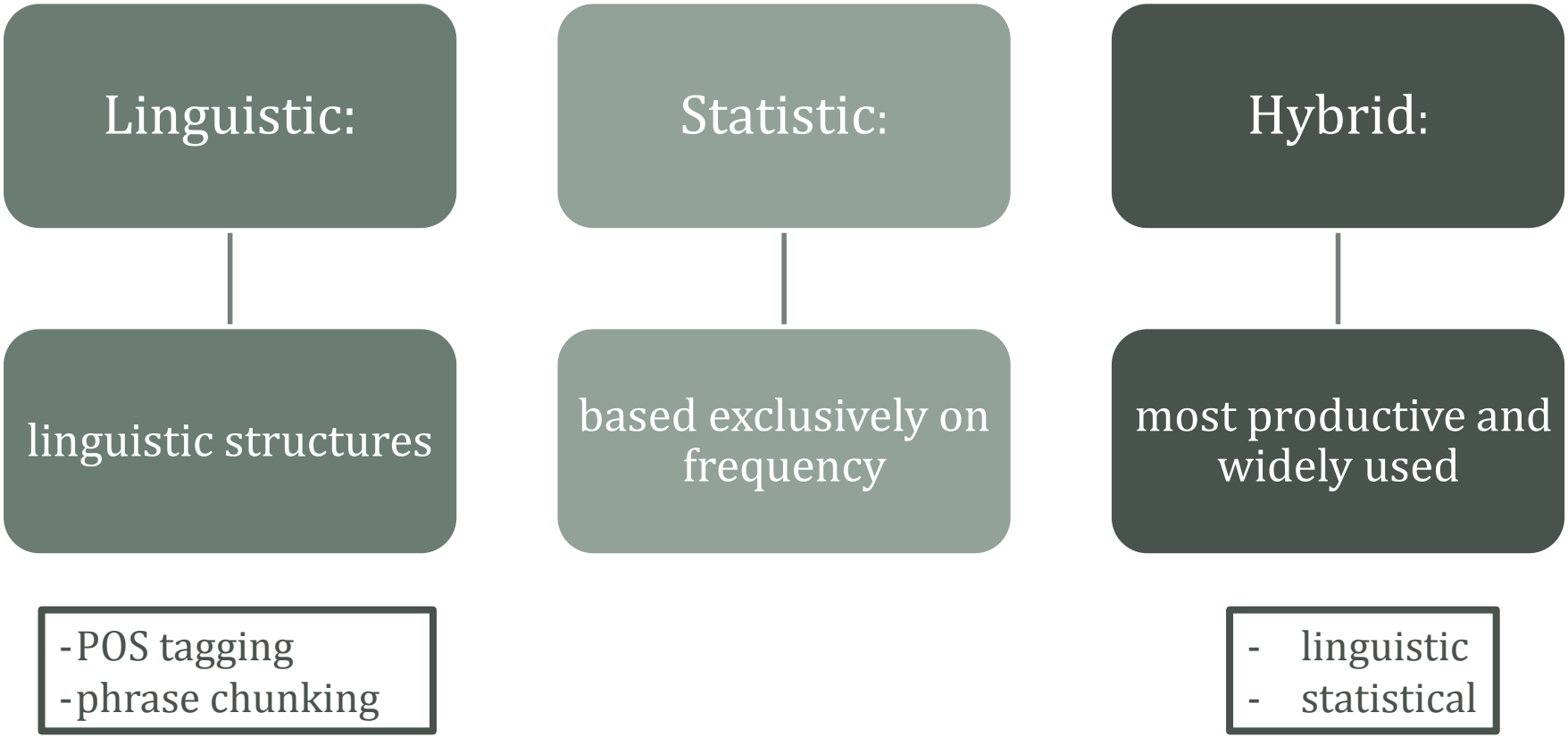
Paper structure

1. Introduction: ATE
2. DEXTER:
    2.1. SRC: A metric for term extraction
        2.1.1. Termhood
        2.1.2. Unithood
3. Dictionaries and thesauri as reference lists
4. Experimentation
5. Discussion of results
6. Conclusions

Approaches to Automatic Term Extraction (ATE)



DEXTER

ATE Workbench

Online access

Specialized corpus

Analysis (hybrid) :

(1) [LINGUISTIC] Shallow lexical filters

  (1) Stopword lists

  (2) No POS tagging

(2) [STATISTIC]

Parameterized Composite Metric

Metric: → Parameters:

- Composite
- User-adjustable
- Unit of analysis: **stemmed n-gram**

· user adjustable

METRICS: What do they tell us?

unithood:

Stability in the relationship within the members of an **n-gram**

- an adaptation of Park, Byrd and Boguraev's Term Cohesion (2002)

termhood:

To what extent an **n-gram** describes/represents the specialized domain

- TF-IDF (Salton, Wong, and Yang 1975; Salton, Yang, and Yu 1975)
- The weight of a term is determined by the relative frequency of the term in a certain document

METRICS

unithood: Stability in the relationship of an **n-gram**

termhood: an **n-gram** represents the specialized domain

Parameters in DEXTER

S alience	Term in relation to the document:
	Unique words, keywords
R elevance	Term in relation to the domain:
	Compared to a reference, general corpus
C ohesion	Term in relation to other terms within an n-gram
	Not only proportional to the frequency of the n-gram, but frequency of items which compose it alone

S alience **R** elevance **C** ohesion

SALIENCE: Unique words, keywords

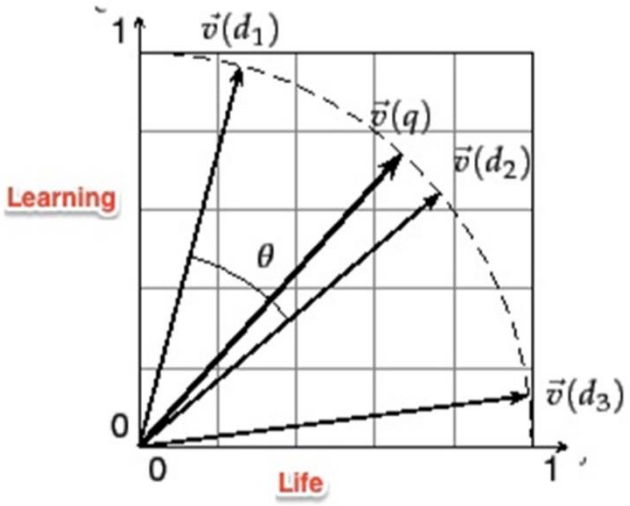
$$\boldsymbol{TF\text{–}IDF}(\boldsymbol{g}) = \boldsymbol{TF}(\boldsymbol{g}) * \boldsymbol{IDF}(\boldsymbol{g}) * \boldsymbol{NORM}(\boldsymbol{g})$$

TF: Term Frequency

IDF: Inverse Document Frequency

NORM: Normalization factor

Vector space models



S alience **R** elevance **C** ohesion

RELEVANCE: Term in the domain

specialized corpus / reference corpus

- Adaptation of Weirdness (Ahmad, Gillam & Tostevin, 2000)

$$R_T(g) = 1 - \frac{1}{\log_2\left(2 + \frac{P_T(g)}{P_R(g)}\right)}$$

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Normalization factor (0-1)

S alience **R** elevance **C** ohesion

Adaptation of Weirdness

$$P_T(g) = \frac{f_T(g)}{|C_T|}, \text{iff } |g| = 1$$

Probability of occurrence

number of n-grams

$|g| = 1$ unigram
$|g| = 2$ bigram

$$P_R(g) = \frac{f_R(g)}{|C_R|}, \text{iff } |g| = 1$$

Salience **R**elevance **C**ohesion

COHESION: consistency of the relation in an n-gram.

Adaptation of Park, Byrd et al.

$$C_T(g) = 1 - \frac{1}{\log_2\left(2 + \frac{f_T(g)}{|g|\sqrt{\prod_{k_i \in g} f_T(k_i)}} \times F\right)}, \text{ iff } |g| > 1$$

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Mean: arithmetic and not geometric.

Normalization factor

$$F = \begin{cases} 1, & \text{iff } f_T(g) = 1 \\ \log_2(f_T(g)), & \text{iff } f_T(g) > 1 \end{cases}$$

Normalization factor NOT for terms with frequency=1

COMPOSITE MEASURE SRC

$$SRC_T(g) = termhood(g) + unithood(g)$$

$$termhood(g) = S_T(g) * \alpha + R_T(g) * \beta$$

$$unithood(g) = \begin{cases} 0, & \text{iff } |g| = 1 \\ C_T(g) * \gamma, & \text{iff } |g| > 1 \end{cases}$$

Working with terminology: dictionaries as reference lists

Specialised glossaries, dictionaries and thesauri

- classificatory structures of knowledge organisation
- common terminological tools used in scientific and technical documentation

- Also used for **pedagogical purposes**
  - LSP courses: lexis in specific domains
  - domain-specific glossaries

Working with terminology: dictionaries as reference lists

- **Lexical resources as reference lists in ATE validation**
  - gold standards in terminology: exemplars of quality /not of perfection.
  - pace at which science and technology require coinage of new terms.
  - neologisms: studied, agreed upon, accepted and finally incorporated into the language, Cabré (2007).
  - lexical resources take a snapshot of language in use at the time of compilation.
  - ATE systems usually extract terms not present in reference lists.

THUS, **reference lists cannot be solely relied upon**.

- For a multilingual platform such as DEXTER: best option of gold standard **IATE**, the multilingual term database of the European Union.

EXPERIMENTATION

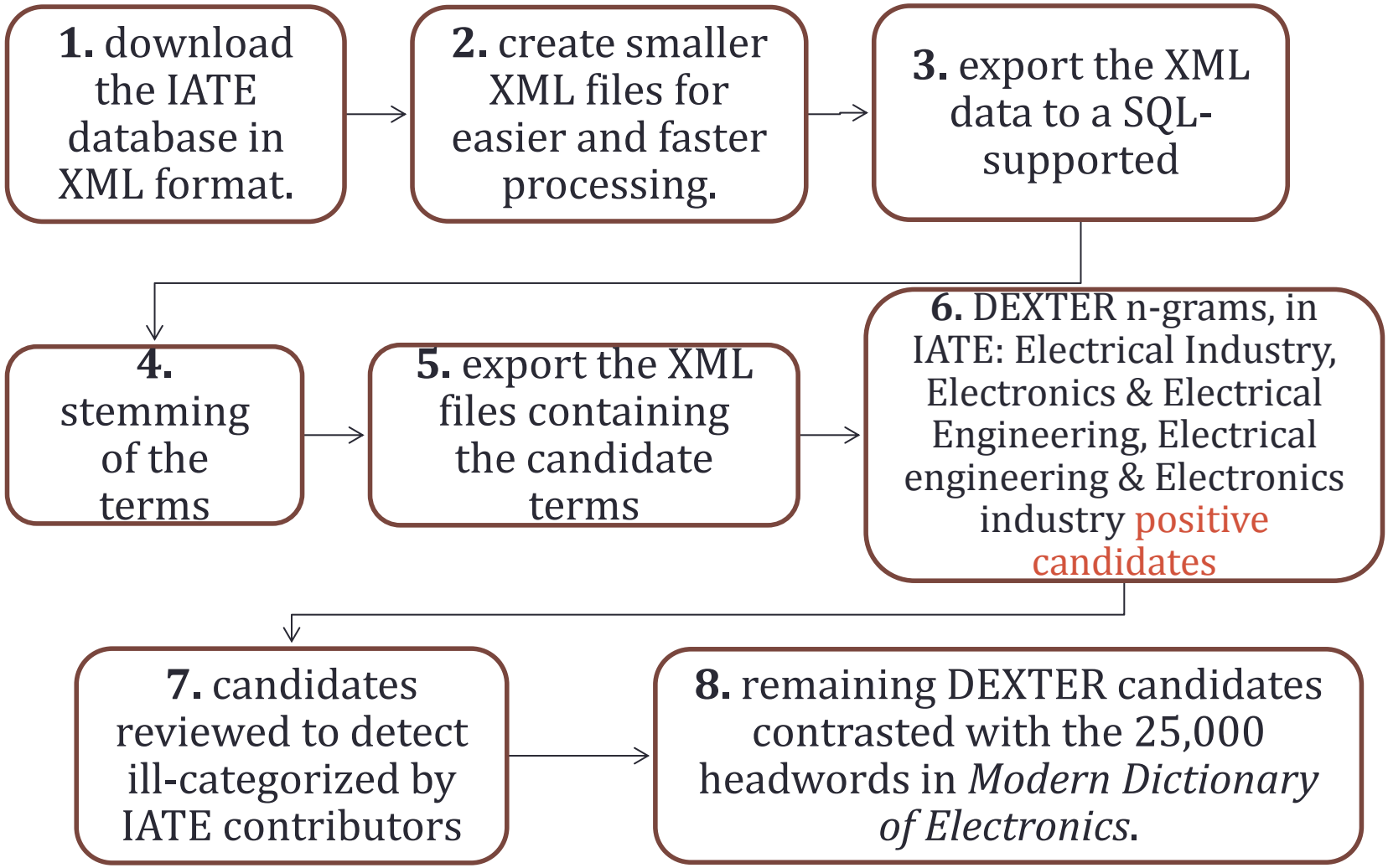
- Small corpus of 46 documents (78,988 tokens)
- Topic: electronics.
- http://www.electronics-tutorials.ws

Subtopic	Documents
AC theory	17
DC circuits	10
Input-output devices	8
Miscellaneous circuits	11

- DEXTER extracted 1,268 unigrams, 1,143 bigrams and 377 trigrams.
- most ngrams: nouns / noun phrases,

  also adjectives (e.g. *capacitive, harmonic, inductive,* or *sinusoidal*) and a few verbs (e.g. *amplify* or *regulate*).

Hybrid procedure of evaluation for SRC. Type-A EVALUATION



Hybrid procedure of evaluation for SRC. Type-B EVALUATION

- Manual validation of candidates not selected as terms in the previous stage.
- Applied to the outcome of the type-A evaluation, so that the problem of subjectivity was minimized.

Hybrid procedure of evaluation for SRC. Type-B EVALUATION

- Corollary 1. **Several lexical items** ($item_i$, $item_{i+1}$, …, $item_n$) can be treated as a **single lexicalization** (*complexItem*) as long as the definition of *complexItem* can be found in the corpus or in any other document resource.
- Corollary 2. **The definition of *complexItem*** must go **beyond** the simple combination of the meanings of $item_i$, $item_{i+1}$, …, $item_n$.
- Corollary 3. **The definition of *complexItem*** must **contain at least one lexical item**, different from $item_i$, $item_{i+1}$, …, $item_n$, which is typically **used to describe the corpus domain**.

The type-B evaluation revealed 12 unigrams, 38 bigrams and 64 trigrams as false negative terms among the top 200 SRC-ranked ngrams

Results for unigrams

#candidates	S	R	f
1-40	0.82	0.45	0.75
41-80	0.57	0.65	0.37
81-120	0.45	0.70	0.42
121-160	0.45	0.62	0.27
161-200	0.47	0.55	0.50
	0.55	0.59	0.46

Precision in the Type-A evaluation of unigrams.

#candidates	SRC	S	R	f
1-40	0.82	0.85	0.60	0.75
41-80	0.72	0.57	0.75	0.37
81-120	0.67	0.45	0.70	0.42
121-160	0.65	0.47	0.65	0.27
161-200	0.57	0.47	0.57	0.50
	0.69	0.56	0.65	0.46

Precision in the Type-B evaluation of unigrams.

Discussion of results

- The integration of two large gold-standard data sets, (IATE / electronics dictionary), is not sufficient.
- Manual validation increased the number of recognized terms proportionally to the complexity of the ngram

	S	R	C
Unigrams	+0.01	+0.06	
Bigrams	+0.16	+0.14	+0.12
Trigrams	+0.24	+0.31	+0.30

- Best precision: SRC for top 200 unigrams, bigrams and trigrams:
  - the combination of metrics can improve the performance of this ATE system.
  - the distribution of terms is better with SRC than with the single metrics.
- For ATE systems focusing on small- and medium-sized specialized corpora, SRC is an efficient, precise measure.

Discussion of results

Categories of false positive candidates among the top 200 SRC-ranked ngrams

i. **Common words**, such as *average*, *maximum* or *value*.

ii. Words typically used in the **description of other specialized domains**, e.g. *complex number*, *root mean square*.

iii. **Words nested in multi-word terms** of the given domain:
unigrams – *nodal* (*nodal voltage analysis*),
bigrams – *width modulation* (*pulse width modulation*),
trigrams –*permanent magnet DC* (*permanent magnet DC motor*)

- proper nouns are almost always part of complex terms: *Kirchoffs* (*Kirchoffs Circuit Law*, *Kirchoffs Current Law* and *Kirchoffs Voltage Law*),

iv. **Mathematical variables and symbols**: Variables X_L, X_C and X_T were converted into the ngrams XL, XC y XT:

Conclusions

SRC

- composite measure for term extraction
- user-adjustable metric based on
  - salience
  - relevance
  - cohesion

DEXTER

- multilingual platform for
  - data mining
  - terminology management
- small- medium-sized specialized corpora.

dictionaries & thesauri: insufficient to evaluate candidate terms

- semi-automatic hybrid approach with human validation

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