TextCoop - LELIE :
A tool kit for authoring requirements

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From two ANR Projects, 2008 – 2013

Main research Questions

– How to make sure that a set of requirements related to an activity or a product is sufficiently clearly written, minimally ambiguous, and sufficiently comprehensive to avoid most misconceptions or risks *(default in production, accident, missing or inadequate features, etc.)?*

– How to make sure that these requirements are acceptable by readers, manufacturers or operators *(i.e. they are understood, accepted, feasible and without any useless considerations) ?*

– How to make sure that a set of requirements of a reasonable size has a good internal conceptual coherence and textual cohesion ?

TextCoop and LELIE: two ANR projects in ADRIA

→ **TextCoop**: analysis of text structure (discourse analysis):

     - (1) global discourse analysis of a document,

     - (2) text cohesion evaluation and control,

     - (3) requirement mining in texts when they are not marked.

→ **LELIE**: tools **dedicated to requirement authoring**, to detect errors not implemented in standard text editors (with CNAM, Paris, tests by EDF):

     (1) follows the principles of technical writing and requirement

              style guidelines, detects forms of non-cohesion,

     (2) produces alerts when errors are detected and suggests corrections

     (3) accepts a variety of types of requirements from software to

     security (a single sentence to long texts).

TextCoop V5.1 + LELIE V2.1: Code Freely available upon request + NDA.

Existing systems: position of TextCoop + LELIE

- **TextCoop:**

very few discourse processing systems, TextCoop: only one based on logic, allows reasoning. Is used as a platform for many applications and teaching.

- **LELIE:**

also very few systems:

      - main one: **RAT-RQA** from the Reusecompany, based on boilerplates + controls, limited cohesion and coherence analysis,

      - others, limited scope and uses: Lexior (Cortim), error checker (Synapse), Rubric (univ. of Luxembourg), Captilo (Prolipsia), etc.

      - **LELIE**: checks all levels of language from morphology to discourse, controls customized to structures, paired with tools to adapt to the domain, suggests corrections.

The <TextCoop> Platform dedicated to discourse analysis

→ Logic-Based platform for processing discourse:

      - general language: analysis of: conditions, circumstances, justifications, illustrations, reformulations, elaborations, purposes, etc.

      - in technical documents: requirements, instructions and titles, prerequisites, warnings, advice, etc.

→ Based on linguistic analysis, rules and patterns, open to customization and extensions.

→ Concurrency managed via a cascade of automata.

→ Can be customized to various domains and languages

→ Result: texts are tagged (XML, dependencies).

A requirement embedded into discourse structures

[[**condition** If T is smaller than 5 mA],

   [**purpose** in order to reach 10mA,

         [**purpose** to start the engine]],

the operator shall plug in a second battery, ← requirement

   [**illustration** for example from store B5 or B6],

[**justification** this will allow a fast and smooth

                  ignition of the engines.]]

→ *Helps to reformulate if too complex*

Rule sample and evaluation

Contrast → conn(opposition whe), gap(G), ponct(comma). /
conn(opposition whe), gap(G), end. /
conn(opposition how), gap(G), end.
conn(opposition whe): *whereas, but whereas, but while*
conn(opposition how): *however.*

structure	number manually annotated	precision (%)	recall (%)
justification	49	92	86
reformulation	27	85	76
illustration	112	91	82
precision	52	90	85
comparison	58	89	85
consequence	12	92	87
contrast	49	86	79
concession	35	89	82

Table 1. Textcoop performances for the identification of discourse relations

Overall structure of a requirement text

\<main-requirement\>

\<title\> **Monitoring safe operation of industrial trucks** \</title\>

\<warning\> Working practices must be monitored by a responsible supervisor \<justification\> to ensure that safe systems of work are followed. \</justification\> \</warning\>

\<purpose\> This list is a basic guide for novices. \</purpose\>

\<subtitle1\> **Operators must always**: \</subtitle1\>

\<requirement\> observe floor loading limits - \<restatement\> in other words find out the weight of the laden truck. \</restatement\> \</requirement\>

\<requirement\> watch out before proceeding \<justification\> because of pedestrians and bystanders \<illustration\>(see paragraph p. 390-394) \</illustration\>.\</justification\> \</requirement\> ....

\<warning\> travel on soft ground \<concession\> unless the industrial truck is suitable for this purpose \</concession\>. \</warning\> ....

\<warning\> never allow unauthorised people to operate the truck. \</warning\>

……   \</main-requirement\>

LELIE: an authoring companion

- **Requirement writing norms**: IEEE830-1998, ISO/IEC/IEEE 29148:2011, ARP4754, INCOSE (Guide for Writing Requirements), IREB, ASD-STE 1001

- **Properties**: verifiable, non ambiguous, comprehensive, coherent

- *Authoring practices analysis*

- *Requirement analysis:* *syntactic + semantic analysis, discourse processing*

- **User feedback**

LELIE: A requirement authoring companion

Controls CNL and business recommendations, produces alerts on:

– General layout of the document: size of sentences, paragraphs, and of the various forms of enumerations, structure of titles, presence of expected structures such as summary, prerequisites, but also text global organization reflecting style guidelines.

– Morphology: in particular passive constructions and future tenses must be avoided,

– Lexical aspects: fuzzy terms, inappropriate terms such as deverbals, and light verb constructions must be avoided; domain terms must be preferred to general terms, various classes of useless terms, verbose terms, buzz terms, etc.

– Grammatical aspects: incorrect requirement structure(s), various forms of negation, incorrect referential forms, long sequences of coordination, complex noun complements, and relative clause embeddings.

– Style: uniformity of expression and position of certain discourse structures must be controlled as required in the domain guidelines,

– Text Cohesion : stable uses of terms (verbs, business terms, etc.), structure completeness.

Structure of Rules

- Each type of error is modelled via a set of rules + lexical data
- Errors are checked within precise discourse structures: e.g. titles, requirements,
- Synchronization is managed by a cascade of automata,
- Large set of linguistic resources dedicated to error analysis, e.g.:

category	number of entries	a priori severity level
manner adverbs	130	2 to 3
temporal and location adverbs	107	in general 2
determiners	24	3
prepositions	31	2 to 3
verbs and modals	73	1 to 2
adjectives	87	in general 1

Table 3. Main fuzzy lexical classes.

A typical, simple output (telecom)

the userer shall indicate if this is an industry **common ERROR:** fuzzy term middleware or a vendor specific one .

the user shall indicate if the ww / os (for example ui , ghf or tuio) is **provided AVOID:** passive construction by a oem or a third party . in the second case , the tender shall detail the name of the manufacturer .

the producer shall detail the redundancy and distribution of the different software modules between servers, how **progressively ERROR:** fuzzy term a process on one ww element **can AVOID:** modal take over from a failing process in another ww element or from a process in a failing ww element **AVOID:** sentence too long .

the producer shall define the best organization to avoid competition between **these** groups **ADVICE: unclear** pronoun reference and the predefined group entities , propose the economic model to be **applied AVOID:** passive construction between **them ADVICE: unclear** pronoun reference and group international wholesalers , and develop internal partnerships **CHECK:** too many relative subordinates **AVOID:** sentence too long .
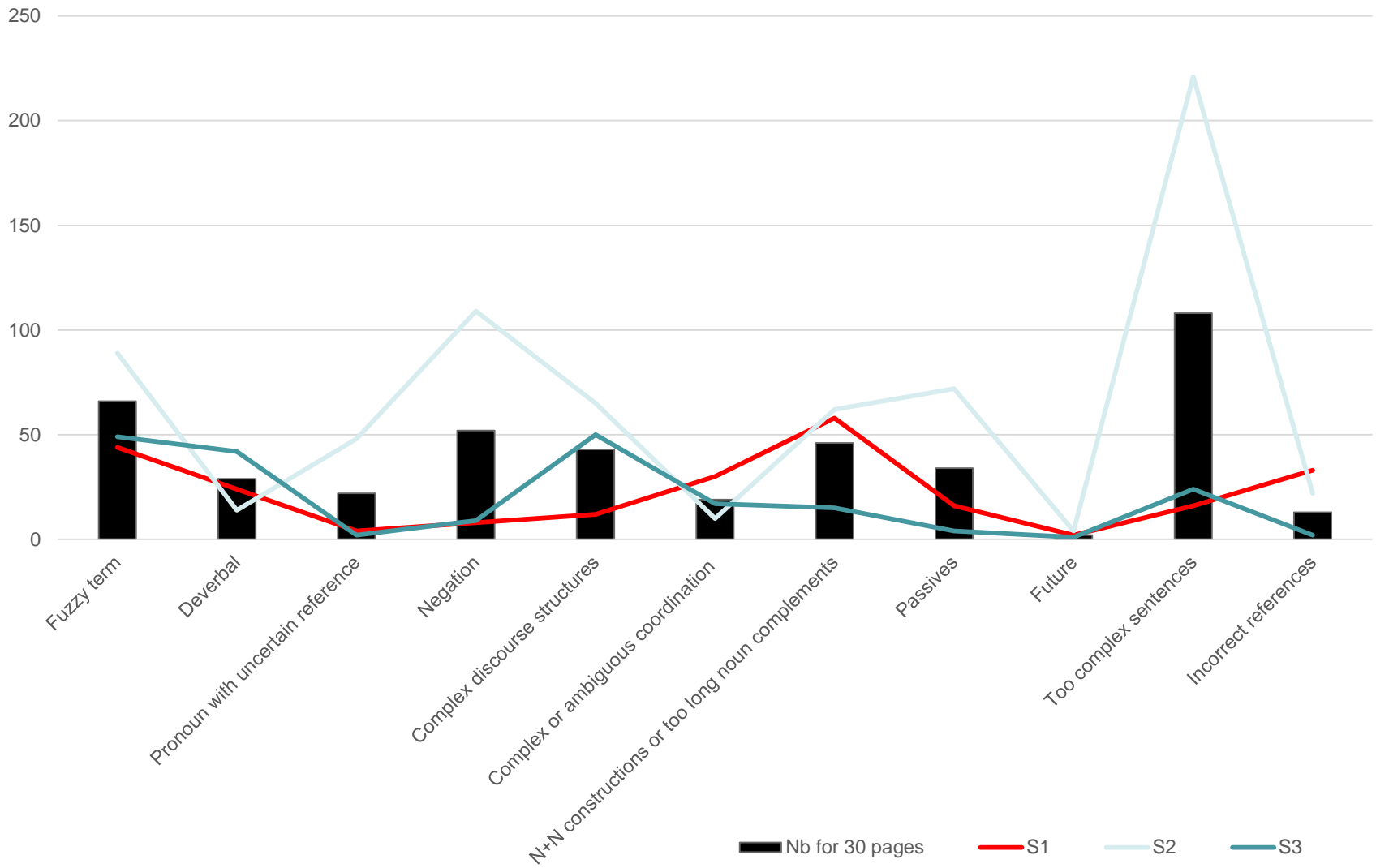
Lexical and grammatical errors

1. from the navigation pane , select an asset class and a type of instrument , for example fixed income government , to see an instant overview of the market.
From **here ERREUR: fuzzy reference** you can click any of the available links to display quotes, quote lists , charts , news , etc.

2. models are ready - to - use screens that let you discover and monitor key real - time information in your markets of interest.
they CHECK: unclear pronoun reference can easily be adapted to your geographic focus and preferences .

3. creating a screen of your own has **never ADVICE avoid negation** been easier

4. you **will AVOID: future use CHECK: verb starting instruction** the password you set now

Complex constructions

if you encounter problems **when** working with TR eikon or receive error messages on **which** **CHECK: too many subordinates** diverses you would like to obtain more information, you can contact support .

click market data **and** tools to view key data **and** access tools such as calculators **and** models ADVICE: too many coordinations

see introduction **to** system test running system test from the product **to** run system test prior **to** **CHECK too many subordinates** diverses installation in the TR eikon system test guide AVOID sentence too long

	Fuzzy term	Deverbal	Pronoun with uncertain reference	Negation	Complex discourse structures	Complex or ambiguous coordination	N+N constructions or too long noun complements	Passives	Future	Too complex sentences	Incorrect references

Legend: Nb for 30 pages, S1, S2, S3

Textual and Lexical Analysis:
Average of amount of errors

Type of Error	Error Severity Level	Global Results French	English
Fuzzy Terms	Variable to Important	193 (66/1000 lines)	37 (74) Judged relevant
Verb Nominalizations	medium	85 (29)	12 (26) But OK, or ambiguous
Modals	medium	16 (5)	63 (130)
Light verb Constructions	moderate	Very few	none
Variety of Verbs	moderate	medium	Very few
Pronouns	medium to important	64 (22)	12 (25)

Errors related to the Grammar

Type of Error	Error Severity Level	Global Reults (French)	English
Negation	Medium to Important	153 (52)	8 (17)
Too many subordinate clauses	Very important	7 (2)	5 (11)
Specific Position of Terms (e.g. the verb)	medium	164 (56)	OK in 68 % cases
Too many conjunctions (coordination)	medium	17 (6)	8 (17)
Too many noun complements	medium	106 (36)	7 (15)
Passive constructions	medium	100 (34)	4 (8)
Future tense	moderate	Very few	Very few (3)
Length of the Sentences	high	316 (108)	7 (15)
Regularity of the enumerations	important	medium	regular
Cross-references	high	39 (13)	6 (13)

Discourse errors and customization complexity

Type of Error	Error Severity Level	Frequency	Complexity of the Processing Operations
Length of sentences	Variable to Important	high	Moderate
Regularity of enumerations	Important	high	Very high
Cross-references	Medium to moderate	medium	weak

Writers' reactions to error messages

(1) do a suitable, validated correction; maybe the system can 'remember' the correction (for himself or colleagues)

(2) Agrees with the error, but discovers it is larger than what has been annotated

(3) make this correction, but with the introduction of another error.

(4) understand the error but without knowing how to correct it: leave it as it is (for a later revision) or ask someone.

(5) look for similar errors to see how they are processed and whether or not they have been processed.

(6) read the error message, but to consider that there is no error; it does not have any impact on the understanding: no correction is done to the text. Ask that such contexts to be no longer highlighted as errors.

(7) Nothing : the system has made an erroneous diagnosis.

Results evaluation

- Alert messages are satisfactory but not always appropriate. The kernel of LELIE contains the CNL rules and lexicons, but no domain specific considerations. Therefore, for the most domain dependent ones:

  - 25% of the alerts on fuzzy terms are not relevant,
  - 20% of those for pronouns with unclear reference,
  - 15% of the passives,
  - 15% of verb uses, etc.

➔ Need to customize the system to the domain:

  - a priori via lexical acquisition ➔ ongoing work on an **auto-adaptative system**
  - or indirectly via the observation of technical writers making corrections from LELIE alerts: **Correction memory.**

Ongoing work: correction scenarios

(1) A **straightforward correction** is suggested by the system: it requires the validation of the writer. May take into account the context of the error.

(2) The correction: **models of standard corrections** are suggested but must be adapted by the writer.

(3) The **correction cannot be customized**: it requires the writer's expertise: the need to correct is highlighted if possible, with the associated severity level.

(1) Corrections suggested by LELIE: lexical and business domains

- Deverbal nominals, passive constructions, future tense: our lexicon includes the associated verbs.

- Light Verb Constructions : corrections are suggested when they exist.

- Business Terms: when they are known, reformulation suggestions can be suggested.

- Favourite Terms : same.

- Modals: models of correction (or simplification) are defined according to the tense, the type of modal and the structure (instruction versus warning).

(2) Correcting modals

CAN:

- *however , should any of these solutions not work , you* can always contact *TR* **contact.**

- you can click *to contact us by phone* **click***.*

MUST:

- you must send users *a modified url* **send users.**

- *you* must have *the administrative rights* *you* **need***.*

WILL:

- *this is the password* you will use *to sign in* **to use***.*

- You will use *the password you set now* **use***.*

 Besides injunctive character, no meaning is lost by these corrections.

(3) Fuzzy terms: some hints

- from **here** you can click any of the available links → navigation pane
- the models presented **here** → **in this section**
- you can also **simply** drag and drop → *skip* simply.
- you can add **various** types of items to your favorites → **different**
- for sites with **few** users → give an interval: **1 to 20 users**
- immediately accept, or **temporarily defer** the proposed updates → or **defer** the proposed dates
- this is **often a lot** easier than **starting** with a blank screen → a lot

Error type	Error pattern	Correction pattern	Example
Fuzzy determiner	[a few Noun]	[less than X Noun] *Adds an upper boundary X	A <u>few</u> minutes --> Less than 5 minutes
	[most Noun]	[more than X Noun] *Adds a lower boundary X	<u>Most</u> pipes shall ... →More than 8 pipes shall...
Temporal, iterative adverbs	[VP(action) Adverb(iterative)] *VP(action): action verb	[VP(action) every X(time)]	The steam pressure shall be controlled <u>regularly</u> →The steam pressure shall be controlled every 10 minutes.
Fuzzy prepositions	[near Noun(location)]	[less than X(distance) from Noun(location)] *X(distance) depends on Context	<u>Near</u> the gate → Less than 100 m from the gate
Negation on usages	[(do) not Verb(use) NP] *NP: any noun *Verb(use) any verb such as 'use'	[Verb(use) hyperonym(NP) other than NP] *Hyperonym(NP) denotes a more generic term than the NP, given in a domain terminology	<u>shall not use</u> hydrogen →shall use a gas other than hydrogen
Reverse synchronization	[do not/never VP before VP'] *VP and VP' denote two actions	[VP only after VP'] or [VP'. Then VP] *Actions are reversed in the correction, some persuasion effects may be lost.	<u>never unplug</u> before the machine has been stopped. →stop the machine. then unplug it

Style according to authoring recommendations

The syntactic remapping includes the following steps :
- 1) the context or the condition of execution
- 2) the requirement(s)
- 3) the justification(s) of these actions + the precautions.

→ These steps are determined by the system's discourse analysis
Example that is possible to correct:

Pour éviter une montée en pression qui peut endommager la vanne T55, en cas d 'évolution anormale de la concentration en bore , de sur-insertion du groupe r , du niveau ballon rcv ou d 'apparition de l 'alarme flux élevé à l 'arrêt, il faut arrêter l'injection du réactif ….

Using TextCoop + LELIE

- Plug-In for a larger system for processing requirements (or any technical doc), can be associated with text editors (Word, pdf, etc.) and editorial suites.

- No interface (depends on environment), generates XML tags

- Open to adaptations (rules, lexicon).

- TextCoop acts as an engine for LELIE,

- TextCoop (about 25 users), LELIE (used in about 7 companies)

→ **TextCoop V5.1 + LELIE V2.1: Open source code + NDA (contact** stdizier@irit.fr or see web page)

→ Can be used as such (In Prolog, efficient and robust!) or as specifications to be coded in a different language (e.g. Java).

Ongoing work

Foundations:

- Development of **text cohesion** analysis at lexical, syntactic and pragmatic levels,

- Development of specific rule for non-native English speakers (IREB project) writing in English,

- Detection of some forms of **incoherence among requirements** (due to typical forms of misconceptions or language errors), on the basis of language patterns. Difficult to get corpus.

Domain and User adaptation:

- **Auto-adaptation** of the system to a domain, from corpus analysis (semi-automatic update of lexicons, business uses, etc.)

- **Learning from writers: correction memory** making corrections to improve the system accuracy (ongoing): supervised method with mediation.

Possible Outcomes of the Work

The main challenge is now the customization of the kernel to a given industrial
Context AND its integration into a requirement management platform.

This includes, among others:
– **accurately testing and customizing the system** to the company's documents so as to filter out
    remaining incorrect error detections (about 20%),
– **introducing domain knowledge** via the domain ontology and terminology, and enhancing the
    rules we have developed to take every aspect into account,
– designing a method for the **incorporation into the system of the authoring guidelines**
proper to a company that may have an impact on understanding,
– implementing the interfaces between the writer's documents and our system,
– **customizing the tags** expressing errors to the various author and validator profiles
and expectations, and enhancing correction schemas.

→ Prospective: Our target is also to include controls on the contents:
(1) **requirements with unusual verb arguments** (e.g. unusual instruments or numerical values,
    provided domain knowledge is accessible) and
(2) **the taking into account of business rules** (e.g. a requirement stating that action A must
    always precede action B).
(3) **Step2-3: controls on the contents and the coherence/overlap among sets of
    requirements.**

# The implementation of the kernel into a requirement working environment

- Management of the interfaces with a text editor (e.g. Word): extract and format the chunks of text, according to our generic input format, and restore the outputs.

- Elaborate correction scenarios adapted to a given situation: when and how these corrections are done (interactive/batch), where and how the help assistance is introduced (correction schemes, lists of synonyms for certain words, suggestions of corrections, etc.)

- Adjust the service to the various actors (writer, hierarchy, validators, operational technicians, etc.)

○ **Design Principles:**

Writers produce what they want/can, the system then inspects what has been produced. No predefined writing templates.

▶ **A customized tool:** We propose a variety of authoring aspects (via parameters) that the writer can choose to control. The system provides annotations with an error severity level, and possibly a summary that gives a partial or global analysis of the document.

▶ **Interactive :** The correction is done by the user on his original document. Writers can update some types of errors (lexical data).

▶ **Flexible :** It adjusts to the writing habits of users: errors can either be systematically marked or only in specific discourse contexts.

General Architecture
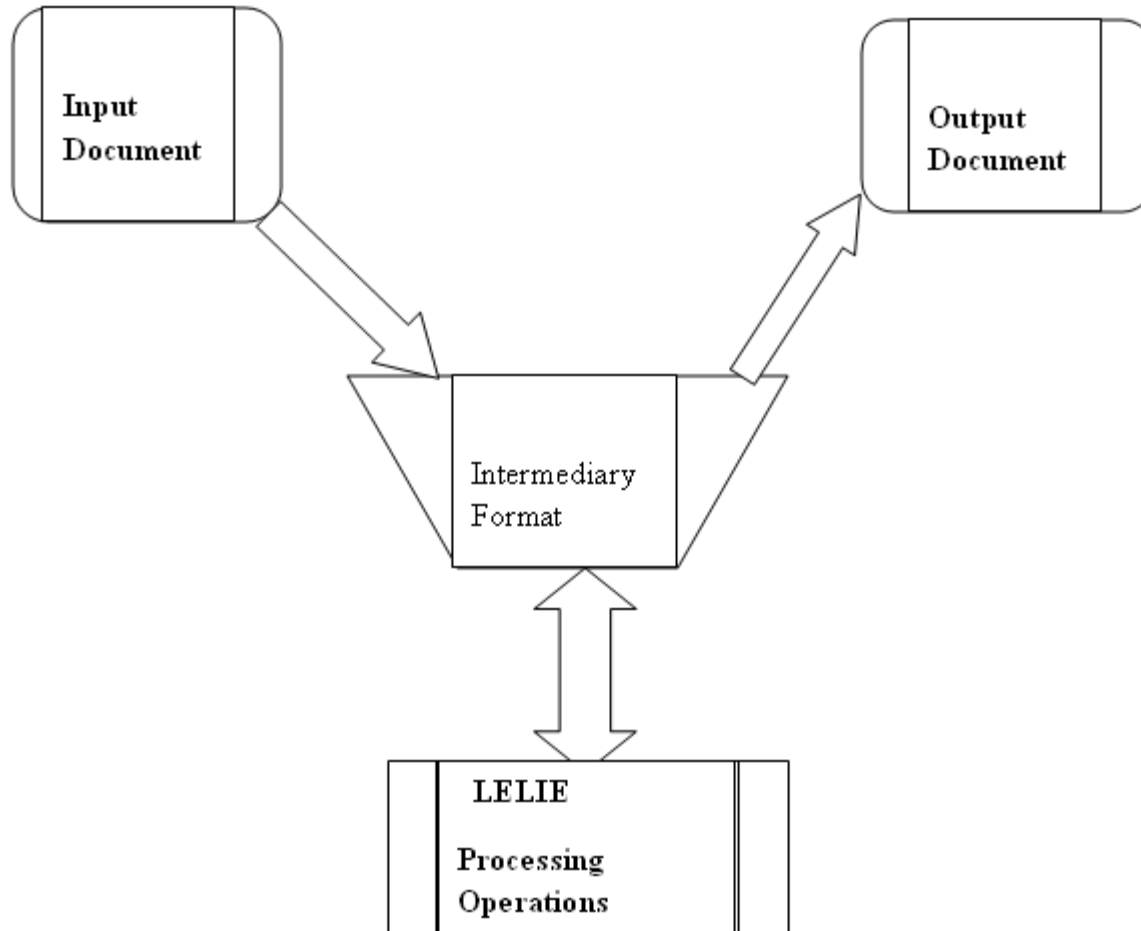
Our work so far:

- Model and implementation: a **kernel** of regular and recurrent errors in all types of documents: **75% of the generic cases have been identified**.

- **Extensible** according to the data, the expectations and the field applications.

- For each type of error: there is often **different levels of severity** according to the context (e.g. fuzzy terms) : **the system is flexible** → the error messages of the system are adjusted to the writer and his needs.

- Generic Processing: independent from the type of source document (but the conversion needs to be done).

- Porting Engineering Development/Customization of the kernel for the industrial context (resources, business).

Synthesis of the Lexical Errors in the Kernel

Type of Error	Error Severity Level	Application Field	Testing Operations	Frequency	Complexity of the Processing Operations
Fuzzy Terms	Variable to Important	instruction	OK	high	Moderate
Verb+ Argument Constructions	Important	instruction	Under process	high	high
Favourite Terms	Moderate	All structures	OK	medium	weak
Terms to avoid	Medium	Id	OK	High	weak
Deverbal Nominals	Medium	instructions	OK	High	Moderate
Modals	Medium	instructions	OK	High	Moderate
Light Verb Constructions in 'faire'	Moderate	instructions	OK	High	Moderate
Business Terms	Medium	All structures	OK	medium	Moderate
Variety of Verbs	Medium	instructions	OK	-	important
Personal Pronouns	Medium to important	All structures	OK	high	Weak

Customization complexity of lexical errors

| Type of Error	Genericity	Customization Effort	Configuration Operations (error levels)	Knowledge	Difficulty of the Task
Fuzzy Terms	high	moderate	Necessary by level	no	moderate
Argument-Verb Structures	important	important	no	To be defined according to each context	high
Favourite Terms	moderate	important	Possible	Ontology/ Field terminology	moderate
Terms to avoid	moderate	important	id	Id or weak	moderate
Deverbal nominals	high	moderate	yes	none	weak
modals	high	weak	yes	none	weak
Light Verb Constructions in 'Faire'	high	weak to moderate	yes	none	weak
Business Terms	weak	high	yes	Field Terminology	medium
Variety of Verbs	weak	high	yes	List available	medium
Personal Pronouns	high	Very weak	yes	none	weak

Synthesis of the grammatical errors in the kernel

Type of Error	Error Severity Level	Application Field	Conducted Tests	Frequency	Complexity of the Processing Operations
Negation	Medium to Important	instruction	OK	high	moderate
Too many subordinate clauses	very important	instruction	In process	High to medium	High
Specific Position of Terms (e.g. the verb)	Medium	instruction	OK	High to medium	Important
Too many conjunctions (coordination)	medium	id	OK	high	Weak
Too many noun complements	medium	instructions	OK	high	Moderate
Passives: to be avoided	medium	instructions	OK	medium	Moderate
Future tense: to be avoided	moderate	instructions	OK	weak	moderate

Customization complexity of grammatical errors

Type of Error	Genericity	Customiza tion Effort	Configuration Possibilities	Knowledge	Complexity
Negation	High	Weak	Necessary on two levels (simple& double neg)	No	Weak, except if syntactic analysis
Too many subordinate clauses	important	Weak	Yes, max number of clauses can be adjusted	No	Medium
Specific Position of Terms (e.g. the verb)	good	weak	Levels are possible	No	Moderate
Too many conjunctions (coordination)	good	weak	Id	No	Moderate
Too many noun complements	Medium to good	medium	Yes	Business Compound words	Moderate
Passives : to be avoided	high	weak	Only one level	None	weak
Future tense : to be avoided	high	weak	id	none	weak

A simple example: overall structure of a requirement

<main-requirement> <title> **Monitoring safe operation of industrial trucks** </title>

<warning> Working practices should be monitored by a responsible supervisor to ensure that safe systems of work are followed. </warning>

<purpose> This list is a basic guide - <circumstance> it is not exhaustive and is not intended to be a substitute for the guidance and training. </circumstance> </purpose>

<subtitle1> Operators should always: </subtitle1>

<requirement> observe floor loading limits - <restatement> in other words find out the weight of the laden truck. </restatement> </requirement>

<requirement> make a planning of their way first <condition> if task is clear </condition>.</requirement>

<requirement> ensure the load is not wider than the width of the gangways.</requirement>

<requirement> watch out before proceeding <justification> because of pedestrians and bystanders.</justification> </requirement> ....

<illustration>(see paragraph 390-394)</illustration>....

<subtitle1> They must never: </subtitle1>

<warning> lift loads that exceed the truck's rated capacity. </warning>

<warning> travel with a bulky load obscuring vision. </warning>

<warning> travel on soft ground <concession> unless the industrial truck is suitable for this purpose </concession>. </warning> ....

<subtitle1> Remember: </subtitle1>

<warning> never allow unauthorised people to operate the industrial truck. </warning>

</main-requirement>
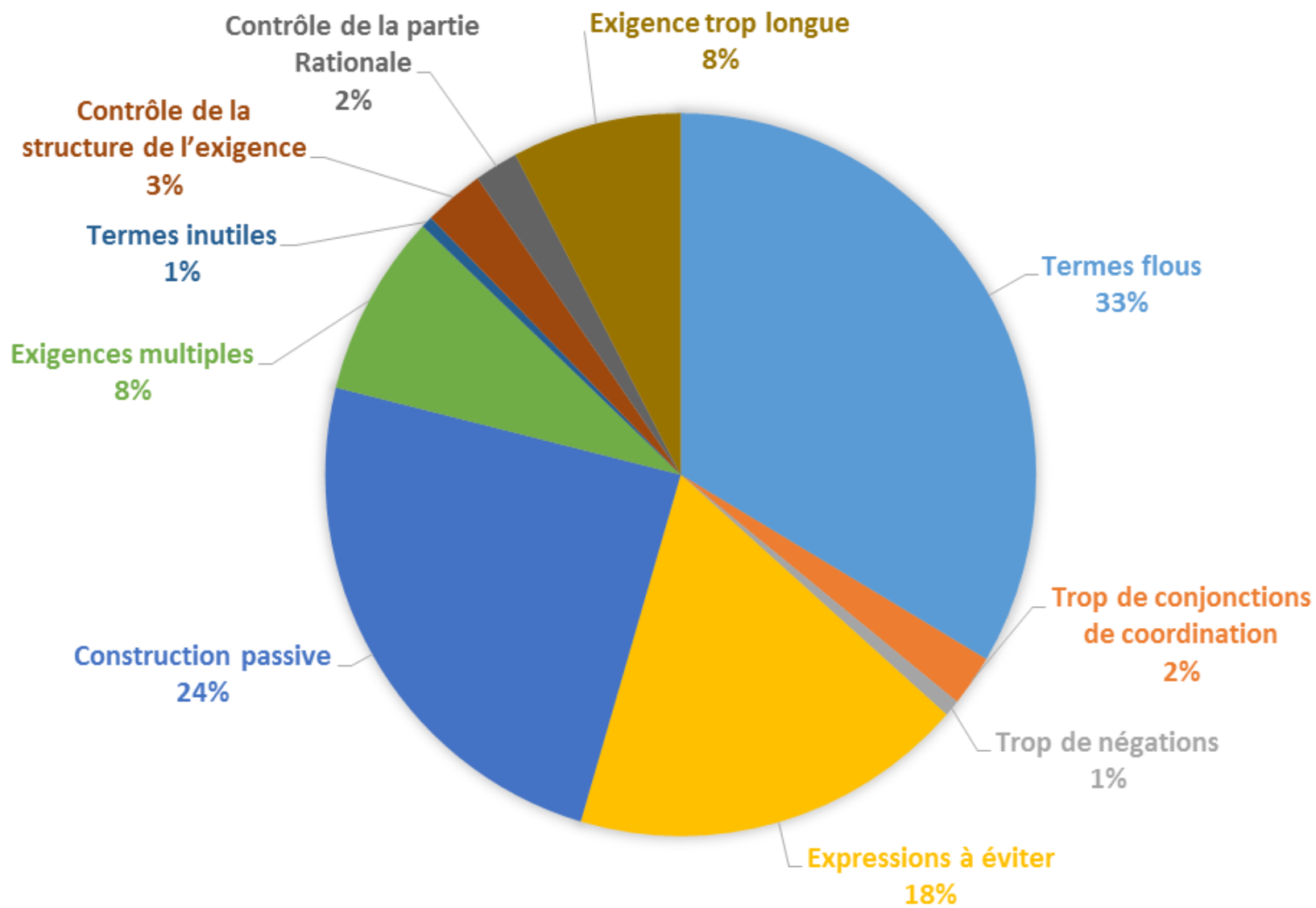
Relatively fuzzy terms

in the **standard ERROR fuzzy term** welcome e - mail from Thomson Reuters, change : https….

the modified url takes you to the first time login page , instead of going through the installation process , as the **standard ERROR fuzzy term** url does

an **approximately ERROR fuzzy term** 5 mb installation bootstrap executable file downloads to your computer

this file does not include the product itself .
It contains **certain ERROR fuzzy term** components required to download Thomson Reuters eikon

as Telecom hosted is designed for sites with **few ERROR fuzzy term** users , the best method….

Prescription 7.6a

Dans le cadre de la prédisposition du secours RRA/PTR, condamner ouvertes les vannes d'isolement intérieur BR suivantes :

- PTR 022VB, PTR 140VB, RRA 114 VB   ┌ Liste exhaustive ┐

Conditions de pose en phase d'arrêt :
- En cas de passage en API SO par ouverture trou d'homme pressuriseur, prédisposer et condamner ouvertes les vannes intérieures enceintes, après avoir déposé la CA « isolement liaison RRA-PTR », juste après l'ouverture du trou d'homme pressuriseur (au TOP presse joint déposé).

- Il est interdit de poser cette CA si le niveau primaire est < NB PT-PJC

- Si la CA est déposée en APR et/ou RCD(non requise), on la reposera uniquement dans le cadre d'un passage en API EO par le TH PZR. Dans ce cas, la poser en APR avant de passer en API.

- On ne la reposera pas dans le scénario de fermeture directe cuve (cf STE)

- ENUMERATION non COHERENTE

Condition de dépose :

- Au redémarrage, déposer cette condamnation administrative et refermer les vannes d'isolement enceinte, et reposer la CA »isolement de la liaison RRA-PTR » sur ces vannes avant le passage en configuration primaire entrouvert (par fermeture du trou d'homme pressuriseur). TROP LONG

- A la descente, en API lorsque le couvercle cuve est levé (piscines remplissables, cf def STE), ainsi qu'en APR, et RCD, cette condamnation administrative est non requise.

Nota : en cas de passage en API SO par ouverture cuve directe, la condamnation n'est pas requise et on ne la pose pas.