

Universal Terminology

CHAPTER 23: LANGUAGE IMPLEMENTATION

This chapter examines the construction of languages in $\mathbf{T}_{logy}$. The first part describes the main aspects of language processing, namely universal formulas and their translation, vocabulary, the grammar of anatomical terms, and the internal structure supporting the terms.

The second part describes all the universal procedures that are implemented, as well as their mirror parts to be carried out for each language.

This document is chapter 23 of the book on *Universal Terminology*, which presents a comprehensive documentation of $\mathbf{T}_{logy}$.

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23.1 The languages of the terminology

Any terminology is known through its implementation and visibility in at least one natural language. However, we have demonstrated that a modern terminology intended for an international audience must be language-independent. Are these two statements contradictory? Certainly not. A terminology is valued by the languages in which it is available, but since all natural languages are conditioned by tradition and usage, not necessarily free of ambiguity and prejudice, and most often uncontrolled by any authority, it must not be based on a single language. Otherwise there is a real risk of being biased towards other languages.

The authors of TA98 believed that Latin could be the reference language for anatomy. Relatively precise, Latin accepts neologisms at will when necessary to express modern sciences. As a dead language, no popular evolution is expected. However, Latin has two weaknesses: first, it is close to Western languages and favors them, and it lacks characteristics of Asian and other languages; second, it has some biases, making it less conducive to the expression of modern sciences. Despite this, it was a good choice for TA98.

Others believe that English is more of a universal language and would be suitable as a reference language. This is a simplistic view: any analysis based on scientific criteria shows that English has multiple problems that prevent it from fulfilling its role as a pivotal language. This is not the place to analyze these problems. We will therefore limit ourselves to listing the main ones:

- English is influenced by multiple, generally uncoordinated, populations. For some of them, it is not the native language as learned in school. Therefore, there is no regulating authority. A *decade* is etymologically speaking according to Greek a period of ten days!
- English has ambiguous grammatical constructions, such as the very popular inverted genitive. When preceded by an adjective, it is unclear which noun is qualified by that adjective. On the other hand, the apposition of two nouns is represented as the inverted genitive without being a genitive. Although this aspect is practically without insurmountable consequences, a terminology based on scientific grounds is problematic in such situations. A *sternum incisura* is a pair of which one member is called a *left sternum incisura*! In the term *external sphincter muscle of anus*, *sphincter* is not a genitive!
- In anatomy, Latin words are sometimes used in English sentences. But, unlike other modern languages such as French or Spanish, English accepts these words as Latin words, in accordance with Latin grammar, so one has to work with a double grammar, without always knowing which is correct. There are three plurals in use for plexus: plexuses, plexi, and plexus!
- There is a long tradition of biased English terminology that must not be propagated into other languages. Such a tradition is certainly valid in English-speaking countries, but it is nonexistent or different elsewhere. The idea of removing the word *muscle* from all terms representing a muscle is an inappropriate simplification in terminology and certainly a source of error.

Concerned with developing a language-independent terminology, the authors of $\mathbf{T}_{logy}$ defined an abstract grammar for representing terms. See in this regard [chapter 09](#). According to this approach, terms are defined as universal formulas, that is, ordered sequences of words, translatable by a formal process into natural language. Universal formulas are completely language-independent, and every $\mathbf{T}_{logy}$ language is based on these formulas. The pivot is the universal formula. The transformation of the universal formula into natural language is the subject of this chapter.

23.2 Formula translation

The translation of a universal formula into a natural language was partially described in [chapter 18](#), devoted to the formula translation phase. It was shown how to perform the transformation of a language-independent abstract framework into a concrete set of natural language texts.

In this chapter, we study the implementation of universal formulas for a specified language. How can we respond to any situation when translating a universal formula? That is the question. In fact, we already have an inventory of these situations, having identified and briefly described all possible universal functions in Chapter 18.

But the task is not limited to these universal functions, since their satisfaction requires a substantial instantiation of the target language. We distinguish three subtasks, listed below:

- **Vocabulary**
Definition of all words in the $\mathbf{T}_{logy}$ in the specified language.
- **Grammar Rules**
Definition of the exhaustive list of rules for the correct grammatical treatment of terms, as well as all exceptions to these rules.
- **Universal Functions**
Implementation of universal functions for the specified language.

The above list of tasks forms the framework for the first part of this chapter. Each task should be examined in detail in the following sections.

23.3 Vocabulary

Vocabulary is the raw material from which terms are constructed. Every language fundamentally has its own vocabulary, regardless of words borrowed from other languages. In the field of anatomy, the specialized vocabulary is well-defined, reasonably large, and generally quite precise. However, as is the case in natural languages, there are words with multiple meanings that require appropriate treatment.

Vocabulary is composed of four categories of words:

- **Nouns**
Nouns refer to anatomical objects or their parts and attributes. They also designate immaterial objects such as spaces or surfaces.

Number of nouns	900
Number of adjectives	1000
Number of prefixes	350
Number of invariants	250
Total number of words	2500
Number of vocabulary units	1700

Table 23.1: Estimate of the size of the $\mathbf{T}_{logy}$ vocabulary. We see that 1,700 units define 2,500 words. This allows us to estimate that half of the units define a single noun or adjective and that the other half of the units simultaneously define a noun and an adjective relating to the same object. The values in this table were estimated in September 2025.

- **Adjectives**

Adjectives qualify a noun by providing additional information or modifying it; or they express a connection with another anatomical object, usually in the form of an adjectival expansion.

- **Prefixes**

Prefixes are like additional adjectives, except they only exist in conjunction with another adjective.

- **Invariants**

Invariants are words that cannot be changed, such as numbers and acronyms.

Other words, such as definite articles or prepositions, may be necessary for the authentic expression of a language. But, in this implementation, they are not considered part of the vocabulary: they are included and generated by the linguistic procedures specific to each language.

Adverbs and conjunctions are prohibited by the grammar of the $\mathbf{T}_{logy}$. They were largely absent in TA98 and there is clearly no need to use them. The adverb *non*, expressing negation, is an exception, and appears a few times. Conjunctions and the comma are no exception, as they are strictly removed, without difficulty.

Prepositions are not strictly necessary, but they provide precision. A gradual implementation of prepositions is underway for some languages.

Based on the estimated number of words in each category of the $\mathbf{T}_{logy}$, the size of the anatomical vocabulary is less than 2,500 words, as shown in figure 23.1. It is interesting to note that only 1,700 vocabulary units are required. This provides an estimate of the vocabulary collection task for the implementation of a new language.

23.3.1 Nouns

Nouns constitute the main words of vocabulary, and the formal grammar of universal formulas is organized around noun phrases, which form the basis of a term and most of its expansions.

Nouns, in general, vary in number, and in Latin and Russian, vary in case. However, several modern languages such as English, French, and Spanish do not have variation in case. Furthermore, nouns have a gender that is important

for the syntax of the adjectives that accompany them in all languages except English. Because of these variations, the grammatical rules governing the syntax of the language must take into account all possible situations.

23.3.2 Adjectives

Adjectives are the most numerous words in the vocabulary. This is not surprising for a descriptive science such as anatomy. In terms, there are often more than one in a noun phrase.

Adjectives, in general, vary in case, gender, and number. In modern languages such as French and Spanish, their variation is limited to gender and number. In English, adjectives are invariable.

In all languages, certain adjectives are considered ordinary adjectives in this implementation: ordinal adjectives and comparative adjectives.

The position of adjectives is before the noun in English, after the noun in other languages. However, some adjectives are before the noun in French.

Because of these variations, the grammatical rules governing the syntax of the language must take into account all possible situations.

23.3.3 Prefixes

Prefixes are quite common and numerous in anatomical language. Indeed, any adjective can be the source of a prefix, but in reality, about a third of them are considered. A prefix generally acts like another adjective, added to an actual adjective. Sometimes two prefixes are even added to the same adjective. Prefixes can also be added to nouns.

A prefix is defined from the same root as its corresponding adjective and often ends in -o. All prefixes are invariable in case, gender, and number.

Some languages prefer to add a hyphen between the prefix and the adjective. In grammar, it was decided to remove all hyphens, in line with the current trend, but there are exceptions.

23.3.4 Invariants

The invariants are cardinal numbers (Arabic or Roman) and acronyms. They do exist in the terminology, even if they are unwelcome. They generally act as mere labels, possibly meaningless to the majority of the terminology's users. Acronyms are difficult to translate and if they are, their meaning tends to get lost.

23.4 Language specific grammar rules

Each language has its grammar formulated in the form of rules. These rules, and a list of exceptions if necessary, allow us to determine variations in gender and number of all words in the vocabulary. The presence of these rules is therefore imperative for term generation.

The basic principles of grammatical rules are as follows:

- A list of exceptions must be handled first. If an exception is raised, the process is stopped.

	EN	FR	ES	RU
Exceptions	24	4	5	8
Rules	14	8	16	25

Table 23.2: Numbers of rules and exceptions relating to the plural of nouns for four modern languages. Latin is not treated according to these rules and exceptions. The large number of exceptions in English is due to the presence of many Latin words that do not follow English syntax.

- A list of rules is established, the order of which is significant.
- All rules are applied in order. If a rule is raised, the process is stopped.
- The last rule always fires. This guarantees a solution.

The various grammar rules used in $\mathbf{T}_{logy}$ are examined below.

23.4.1 Plural of nouns

Vocabulary nouns are specified in the nominative singular. The syntactic rules for the plural must determine the nominative plural.

The recommended approach is to specify the singular ending and the plural ending that must replace the previous one, under the cover of a list of exceptions specifying that the right-hand side of the exception is the plural of the left-hand side. This list of exceptions must cover all situations where the plural cannot be determined by a rule.

The formal procedure is as follows:

- Select a noun in the nominative singular case.
- Check if this noun is a left-hand side of an exception to this rule.
- If yes: trigger. The result is the right-hand side of the exception list. Exit.
- Loop through all the rules in the proposed order and apply each rule individually until one triggers.
- Check if the singular ending applies to the selected noun.
- If yes: trigger. Remove the singular ending and replace it with the plural ending.
- The result is the noun in the nominative plural case. Exit.

In the table 23.2, we can see the size of the plural rules as well as their list of exceptions. It is not certain, although likely, that all natural languages are compatible with such a small number of rules and exceptions. In any case, the numbers given here are small, and the process is guaranteed to be effective in all known languages.

The tables of rules and exceptions for French nouns and adjectives are shown in figure 23.1.

```

// Rules for plural of nouns and adjectives:
// The below list presents all the rules governing the
// creation of plural words from their singular counterpart.
cWordRuPluralFR: tWordRuPluralFR = (
  ( 's', 's' ),      // biceps, dos, pancréas, pénis, stapès
  ( 'x', 'x' ),      // faux, squameux, cortex, fornix
  ( 'al', 'aux' ),    // bicipital, vertébral, canal, tibial
  ( 'ail', 'aux' ),    // travail, émail
  ( 'au', 'aux' ),    // peau, noyau,
  ( 'eu', 'eux' ),    // cheveu
  ( 'z', 'z' ),      // nez
  ( ' ', 's' ) );    // aorte, aortique, palai

// Plural exceptions for nouns:
cNounExPluralFR: tNounExPluralFR = (
  ( 'caillou', 'cailloux' ),
  ( 'genou', 'genoux' ),
  ( 'œil', 'yeux' ),
  ( 'pou', 'poux' ) );

// Plural exceptions for adjectives
// Singular, plural
cAdjExPluralFR: tAdjExPluralFR = (
  ( 'natal', 'natals' ) );

```

Figure 23.1: Data structures for storing rules and exceptions for French nouns and adjectives.

23.4.2 Plural of adjectives

The adjectives in the vocabulary are specified in the nominative masculine singular. Rules are provided to obtain the equivalent feminine and neuter forms, where applicable. The syntactic rules for the plural must determine the nominative plural form for all three genders.

23.4.3 Gender of nouns

The gender of nouns in the vocabulary is not specified and must be determined by appropriate rules. Syntactic rules allow the gender of any noun to be determined.

23.4.4 Gender of adjectives

Adjectives in the vocabulary are specified in the masculine nominative singular. Syntactic rules must determine the feminine nominative singular and the neuter nominative singular.

The data for determining the gender of adjectives in Spanish can be seen in Figure 23.2.

23.5 Term Implementation

The major task of the software supporting T_{logy} is undoubtedly the generation of terms naming anatomical entities. This process must be performed in multiple languages based on highly formalized abstract content. It is essential to maintain consistency in the quality of the generated terms so that no language has a

```

// Exceptions for gender of adjectives
cAdjExGenderES: tAdjExGenderES = (
    ( 'azygos', 'azygos' ),
    ( 'ambiens', 'ambiens' ),
    ( 'común', 'común' ),
    ( 'grácil', 'grácil' ),
    ( 'gris', 'gris' ),
    ( 'hamate', 'hamate' ),
    ( 'haploide', 'haploide' ),
    ( 'trapezoide', 'trapezoide' ),
    ( 'tricúspide', 'tricúspide' ),
    ( 'cúspide', 'cúspide' ),
    ( 'marrón', 'marrón' ),
    ( 'oriens', 'oriens' ),
    ( 'proyectable', 'proyectable' ),
    ( 'reuniens', 'reuniens' ) );

// Rules for gender of adjectives
cAdjRuGenderES: tAdjRuGenderES = (
    ( 'o', 'a' ), // blanco, gastrico
    ( 'al', 'al' ), // abdominal, arterial, glial
    ( 'an', 'an' ), // iridian
    ( 'ante', 'ante' ), // disecante, gigante
    ( 'ar', 'ar' ), // ampular, ciliar, cóclear
    ( 'ente', 'ente' ), // abducente
    ( 'er', 'er' ), // bacillifer
    ( 'il', 'il' ), // senil, grácil
    ( 'oides', 'oides' ), // cricoides, escafoides
    ( 'or', 'or' ), // anterior, excretor, flexor
    ( 'orme', 'orme' ) ); // ansiforme, fusiforme

```

Figure 23.2: Data structures for storing rules and exceptions for the gender of adjectives in Spanish.

different understanding of the terms than the others. These are key success criteria.

The construction of an anatomical term in a given language is carried out in several stages. Each stage builds on the work of the previous stages and adds new information. After the last stage, the anatomical term is fully formed and ready for display. It is therefore necessary to have a data structure capable of storing all the information obtained in one stage and transmitting it to the next.

23.5.1 Term Structure

An anatomical term is stored in a record of type *tTerm*. This structure is usually modeled for each XX language, yielding **tXXTerm = class(tTerm)**. Since an anatomical term is formed by a sequence of words, the data structure supporting a term *tCells*, a property of *tTerm*, is defined as a set whose generator is a structure supporting a single word. This structure *WordAnal* is a record of 6 elements, allowing the exhaustive capture of the grammatical information specifying any word (plus 2 elements specific to Latin). These elements are now described:

- The word in the form described by the other elements.
- The word in its base form in the nominative masculine singular.
- The case of the word according to the type *tWordCase*.
- The category of the word according to the type *tWordCateg*.
- The gender of the word according to the type *tWordGender*.
- The number of the word according to the type *tWordNumber*.

These data structures are described in the term generation software, as seen in figure 23.3.

Furthermore, the types of the elements used are visible in figure 23.4.

23.5.2 Construction of an English term

To illustrate the process of generating anatomical terms, it is interesting to examine the generation of a chosen term and observe all the stages through the evolution of the data structure *WordAnal*. To do this, the term EN:*semilunar folds of colon* was selected. This is a set unit with a mandatory expansion to another entity, the EN:*colon*. Since this term is a set type, it must therefore be presented in the plural.

→TAH2619

LA: *plicae semilunares coli*
EN: *semilunar folds of colon*
FR: *plis semilunaires du côlon*
ES: *pliegues semilunares del colon*
RU:

The formula for this term is N(12816),P(12037),A(11961). It applies to all languages.

The construction takes place in four distinct steps, detailed below.

<pre> { * Storage of an analyzed words in a term * Description: This record stores the result of analysis of a word as found in a tTerm structure, as described in the following table: <TABLE> Field Explanation ----- Wrd the variable word as found in the term LID unique identifier of word in Latin dictionary Cla class to which the present word belongs Lem representative form of the word (mns) Cas case of the word Typ category of word Gnd gender of word Num number of word </TABLE> WordAnal = record Wrd: String; // the word in reality LID: String; // identifier in Latin dictionary Cla: String; // class from Latin dictionary (not used) Lem: String; // the source word: nominative. sing. masc Cas: tWordCase; // case of the word: u, n, g Typ: tWordCateg; // category of word: u, n, a, p, i Gnd: tWordGender; // gender of word: u, m, f, n Num: tWordNumber; // number of word: u, s, p end; { Type for cells for term analysis } tCells = Array of WordAnal; </pre>	
---	--

Figure 23.3: Data structures for storing an anatomical term. This structure is the same for all languages and supports all grammatical situations.

- **Step 1: Translation of the formula and word ordering**

Processing the formula generates three words, for English, in the reverse order of the formula. This step is performed by the universal function UnivSetFormula.

- **Step 2: Syntax adjustment**

Checking the agreement of adjectives, if applicable, with the noun they accompany. This step is skipped in English. This step is performed by the universal function UnivGender.

- **Step 3: Mandatory expansion**

Generation of the mandatory expansion and placement in the genitive case. This step is performed by the universal function UnivMakeMandat.

- **Step 4: Pluralization**

Pluralization of the nominative part of the term. This step is accomplished by the universal function UnivPlural.

After the last step, it is possible to read the structure supporting the term. This reading takes each word in the structure in sequence and adds spaces where necessary. Thus, the final term is available. The evolution from step to step can be observed in Figure 23.3.

Each step is performed by a universal function designated above. In fact, it is the version of the universal function for the current language that is called. A detailed description of each of these functions is provided below.

tWordCateg	<pre> { Enumeration type for Latin word categories } = (wt_undef, // undefined wt_nou, // substantive wt_adj, // adjective wt_com, // comparative adjective wt_ord, // ordinal adjective wt_mod, // modal prefix type m wt_pre, // prefix wt_prf, // other prefix wt_inv, // invariant acronym wt_plh, // standard placeholder type h wt_pls, // short placeholder type s wt_ppr, // preposition wt_def); // definite article </pre>
tWordGender	<pre> { Enumeration type for Latin genders } = (gd_undef, // undefined gd_mas, // masculine gd_fem, // feminine gd_neu); // neutral </pre>
tWordNumber	<pre> { Enumeration type for Latin numbers } = (nb_undef, // undefined nb_sing, // singular nb_plur); // plural </pre>
tWordCase	<pre> { Enumeration type for Latin cases } = (wa_undef, // undefined wa_nom, // nominative wa_gen); // genitive </pre>

Figure 23.4: Definitions of the types used for the grammatical representation of terms.

	Wrd	Lem	Case	Typ	Gnd	Num
step 1	semi	semi	wa_name	wt_pre	gd_undef	nb_undef
	lunar	lunar	wa_nom	wt_adj	gd_undef	nb_undef
	fold	fold	wa_name	wt_nou	gd_mas	nb_sing
step 3	semi	semi	wa_name	wt_pre	gd_undef	nb_undef
	lunar	lunar	wa_nom	wt_adj	gd_mas	nb_sing
	fold	fold	wa_name	wt_nou	gd_mas	nb_sing
	of	of	wa_gen	wt_ppr	gd_undef	nb_undef
	colon	colon	wa_gen	wt_nou	gd_mas	nb_sing
step 4	semi	semi	wa_nom	wt_pre	gd_undef	nb_undef
	lunar	lunar	wa_nom	wt_adj	gd_mas	nb_plur
	folds	fold	wa_nom	wt_nou	gd_mas	nb_plur
	of	of	wa_gen	wt_ppr	gd_undef	nb_undef
	colon	colon	wa_gen	wt_nou	gd_mas	nb_sing

Table 23.3: This table shows the data structure supporting a term. Here, in three steps, the term EN: *semilunar folds of colon* is formed.

	Wrd	Lem	Case	Typ	Gnd	Num
step 1	plica	plica	wa_nom	wt_nou	gd_fem	nb_sing
	semi	semi	wa_name	wt_pre	gd_undef	nb_undef
	lunaris	lunaris	wa_nom	wt_adj	gd_undef	nb_undef
step 2	plica	plica	wa_nom	wt_nou	gd_fem	nb_sing
	semi	semi	wa_name	wt_pre	gd_undef	nb_undef
	lunaris	lunaris	wa_nom	wt_adj	gd_fem	nb_sing
step 3	plica	plica	wa_nom	wt_nou	gd_fem	nb_sing
	semi	semi	wa_name	wt_pre	gd_undef	nb_undef
	lunaris	lunaris	wa_nom	wt_adj	gd_fem	nb_sing
	colon	colon	wa_gen	wt_nou	gd_mas	nb_sing
step 4	plicae	plicae	wa_nom	wt_nou	gd_fem	nb_plur
	semi	semi	wa_name	wt_pre	gd_undef	nb_undef
	lunares	lunares	wa_nom	wt_adj	gd_fem	nb_plur
	coli	colon	wa_gen	wt_nou	gd_mas	nb_sing

Table 23.4: This table shows the data structure supporting a Latin term. Here, in four steps, the term *LA:plicae semilunares coli* is formed. While English generates a term with five words, Latin only needs four words. The terms in each language are semantically perfectly equivalent.

23.5.3 Construction of a Latin Term

It is interesting to compare the generation of a term in two different languages. To do this, see figure 23.4 for the development of the same term in Latin. The four steps are the same as for the English term.

23.6 Universal functions

Universal functions are functionally language-independent procedures, whose role is to encompass the required processing, including all the specificities dependent on the target language. Universal functions are called with the simple purpose of transferring control to the target language-specific function. The data structures for their processing are unique and language-independent. In this way, the body of the term generation software can operate without having to worry about the target language. This means that as many target languages as desired can be added without affecting the main body of the software. This is how the $\mathbf{T}_{logy}$ can be described as language-independent.

The general form of universal functions is shown in figure 23.5. We can see how a single call to a universal function is transformed into a call to a specific function created for the target language.

The universal functions are listed in Chapter 18, along with a brief description. In this chapter, each universal function is documented individually. In particular, a complete set of specifications to be met, regardless of the target language, is established.

In the following presentation of universal functions, a language is referred to as XX, where XX takes the following values: *Latin* for Latin, *EN* for English, *FR* for French, *ES* for Spanish, and *RU* for Russian.

A function, for example **tTerm.UnivPlural**, calls a procedure specific to

```

function      tTerm.UnivPlural()
:            String;
{<~~~~~
 * Universal function for the property Plural *
 Description:
 This procedure retrieves the language of the current term and dispatch to
 the specific procedure valid for this language. A recasting of the object
 class is necessary in order to reach the specific language class.</P>
 This procedure transforms a language term at nominative singular to
 the nominative plural. It leaves unchanged any possible other parts like a
 genitive.</P>
 StandardDoc/04.03.25
 ~~~~~}>
begin
|case Self.fLg of
  lt_Latin:   Result := tLatinTerm( Self ).UnivPluralLA;
  lt_English: Result := tENTerm( Self ).UnivPluralEN;
  lt_French:   Result := tFRTerm( Self ).UnivPluralFR;
  lt_Spanish: Result := tESTerm( Self ).UnivPluralES;
  lt_Russian: Result := tRUTerm( Self ).UnivPluralRU;
  else       Result := cEmpty;
end;
end; // _____ UnivPlural

```

Figure 23.5: General form of universal functions. The sole role of such a function is to transfer control to the specific implementation procedure for the target language. This example concerns the function *UnivPlural*.

language XX as follows: **Result := tXXTerm(Self).UnivPluralXX** with **tXXTerm = class(tTerm)**.

23.6.1 UnivPlural

This universal function transforms a singular term into a plural term. Only the nominative part of the term is affected by this function. The plural is obtained by transforming each noun or adjective from the nominative singular to the plural, the other words remaining unchanged.

An example implementation of this universal function is given in figure 23.6, as implemented for French.

Specifications:

- The initial term is an object of type *tTerm*, which contains the term's *tCells* structure: its *IsRegular* property is true, meaning that the term is derived from a universal formula. Otherwise, a result without processing is returned.
- The initial term is well-formed, in particular its *Node* property of type *tCells* has been correctly set.
- The initial term is converted to the language-specific equivalent of *tTerm*. The *fLg* property provides information on the current language.
- Any noun or adjective given in the singular is transformed into the plural by the *UnivWordPlural* function.
- The term is processed in the order of all cells in the *Node* property.
- The words in the noun part of the term are the only words that can be modified. Furthermore, among these words, only nouns and adjectives are subject to modification, depending on the language.
- The final term in full-text plural is constructed as a string of words separated by spaces where necessary, which will be returned as the result value of the procedure.
- Elisions are performed if necessary, depending on the language requirements, by the *UnivElision* function.
- A new *NodeGS* property is constructed corresponding to the final term.

23.6.2 UnivLateral

```

for Indx := 0 to NbAnal - 1 do
begin
  MyCell := Self.Node[ Indx ];
  MyType := MyCell.Typ;
  MyWord := MyCell.Lem;

  // Check for nominative part
  IsNom := MyCell.Cas = wa_nom;
  IsPref := ( myType = wt_mod ) or ( myType = wt_pre ) or
    ( myType = wt_prf );

  // Prepare the nouns or adjectives at plural and adjust the cell
  if ( ( MyType <> wt_inv ) and ( MyType <> wt_ppr ) and
    ( MyType <> wt_def ) and ( not IsPref ) and ( IsNom ) ) then
  begin
    MyCell.Wrd := WordPluralFR( MyWord, IsRule, Ident );
    MyCell.Num := nb_plur;
  end;

  // Creation of the new word and cell
  if ( not LastPref ) then
  begin
    Plural := Plural + cSpace;
    Plural := Plural + MyCell.Wrd;
    Self.NodeGS[ Indx ] := MyCell;
    LastPref := IsPref;
  end; // for on all words

```

Figure 23.6: Excerpts from the UnivPluralFR procedure. We can observe the loop through all the words in the term. In the middle, we have a complex condition that selects only nouns and adjectives in the nominative case: they are transformed into the plural using the universal function UnivWordPlural, which calls UnivWordPluralFR. The new term is constructed in the variable *Plural*, and the corresponding grammatical cells are stored in the variable NodeGS.

23.6.3 UnivGender

This universal function transforms a base term by adjusting the adjectives to the gender of the main noun in that term. The gender of the main noun is retrieved, and all nominative adjectives in the base term are in turn adjusted to this gender.

Specifications:

- The initial base term is generated by the UnivSetFormula procedure for the current language. At this point, the adjectives of the base term are in the nominative singular, without matching the head noun of this term.
- This universal function is required for Latin, French, Spanish, and Russian, but does not exist for English, where adjectives are invariable.
- The head noun of the base term is retrieved. Its position depends on the language. In most cases, such a noun is present. Otherwise, this function fails.
- The gender of the head noun is retrieved as defined by the UnivSetFormula procedure.
- A scan of all words in the term is performed, retaining only adjectives in the nominative case.
- For each adjective, a transformation to the gender of the head noun is performed.
- The base term is fully adjusted and returned.

23.6.4 UnivLatPlural

23.6.5 UnivFormalLatPlural

23.6.6 UnivGenitive

23.6.7 UnivGenPlural

23.6.8 UnivGenLatPlural

23.6.9 UnivFormalPair

23.6.10 UnivDisplayPair

23.6.11 UnivFormalSet

23.6.12 UnivFormalPset

23.6.13 UnivMakeMandat

This universal function is activated each time a mandatory expansion for a term has been specified. Such a specification is under the form of an entity identifier. The main term of the pointed entity is retrieved and appended as a genitive to the calling base term. The expansion is commonly at singular, but on request it may be at plural, implying a genitive plural form. The expanded part is by default appended to the right of the main term, but this may be changed for Latin traditional terms.

Specifications:

- A mandatory expansion is specified to an existing entity.
- The specified entity is retrieved and its main term is built, including the placeholders. It should be noticed that the expansion itself may recursively have its own expansion.
- The universal function is call with this term and two parameters: the plural flag for an expansion at plural and the position of expansion (for Latin traditional terms only), set to zero by default meaning expansion appended after the rightmost word of the main term.
- The genitive of the expansion is computed by the adhoc universal function, taking care of the plural flag.
- The expanded part is inserted in the main term at its specified position.

23.6.14 UnivMakeAdjective

This universal function specifies an adjective, possibly prefixed, as an expansion to the base term to be positioned as the main adjective of the base term. This adjective, in contrary to the adjectives of the base term, is specified by an entity identifier, the adjective being declared as the representative of this anatomical entity. An eventual prefix is specified on the same manner. An adjective expansion may be inherited as a mandatory expansion and vice-versa: one can be transformed into the other because both are specified in the same way by an identifier. This capability gives an additional power to the representation of the internal network of the terminology for relations between entities.

Specifications:

- An adjective expansion is specified to an existing entity.
- An adjective expansion may be accompanied by a prefix.
- The specified entity must have a vocabulary entity declared as its representative, this entity must have an adjective (prefix) in the list of its words.
- The adjective is retrieved and its form is computed regarding the local syntactical constraints in case, gender and number, whatever is relevant.
- The adjective is inserted into the base term of the calling entity, as the main adjective, this means directly adjacent to the noun of the base term.
- The base term is reestablished as a new string.

23.6.15 UnivMakeOption

This universal function is activated each time an optional expansion for a term has been specified. Such a specification is under the form of an entity identifier. The main term of the pointed entity is retrieved and appended as a genitive to the calling base term. The expanded part is always appended to the right of the main term. An optional expansion is similar to a mandatory expansion, except that the term can be displayed with or without the expansionm, depending on the context. There is a complication with the optional expansion due to the fact that for bilateral entities the mandatory part may change when the optional part is present or not.

Specifications:

- An optional expansion is specified to an existing entity.
- The specified entity is retrieved and its main term is built, including the placeholders. It should be noticed that the expansion itself may recursively have its own expansion.
- The universal function is call with this term without other parameters
- The genitive of the expansion is computed by the adhoc universal function.
- The expanded part is inserted in the main term at its right.

23.6.16 UnivMakeLateral

23.6.17 UnivSetFormula

This universal function is call when a universal formula must be decoded and translated in a target language. The expected result is a regular term for this language. For this complex procedure, a vocabulary is available with a multi-lingual setting. Each word referred by the universal formula is described by a vocabulary entity, which contains the different forms of that word (noun, adjective or prefix) usually in all languages. The raw material represented by vocabulary must be assembled according to the syntax rules of the target language: there is a one to one relation between the universal grammar and the specific language grammar, in such a way that the delivered term is uniquely defined and non ambiguous.

Specifications:

- The universal formula is wellformed in concordance with the universal grammar.
- The present function uniquely processes the base part of the formula.
- It is assumed that the referred vocabulary entities are always satisfied for the present target language. If not, the translation is not possible for this language.
- All aspects of the universal grammar must be conveniently handled by the present function, unless these aspects are absent of the actual formula. A partial setting of this universal function is acceptable.
- This function has two parts: 1) the raw assembly of the words; 2) the controle of the syntax between dependant words like concordance in case, gender and number.
- For the assembly of words, the order of the formula being the Latin order, the real order must be redefined for the target language.
- The final term as a full text string is provided.

The tXXTerm.UnivSetFormulaXX procedure is rather complex. It is basically made of two parts: a loop on all words as present in the universal formula; a debranching on each category of word for a specific management. There are few interrelations between words except the syntax links (see below): they are the prefixes not blank separated and the noun complements with a language specific placement. Finally, the syntactical interrelations are managed in a local procedure.

23.6.18 UnivSetNominative

This universal function, at reception of a text value, builds a nominative singular term in the specified language. It is necessary for the terms that are not issued from a universal formula, but by a dedicated text. This text is supposed to be regular reagrding the formal grammar of the universal formulas. The received text is analyzed for the presence uniquely of nouns and adjectives, all considered at nominative singular. When this condition is not met, the term must be specified by an extra universal formula.

Specifications:

- The received text value is a base term of type `st.bas` made uniquely of a single noun and any number of adjectives.
- The prefixed adjectives are accepted but will not be recognized as such.
- The appositions, noun complements and invariants are not accepted. If present, the result is not guaranteed.
- The noun and the adjectives are all supposed to be singular.
- The noun gender is defined.
- Any adjective gender is computed in accordance to the noun, depending on the language.
- The grammar cells are computed for each blank separated word in the term.
- Finally, the term is set as regular.

An example of a language implementation of this universal function is given in figure [23.7](#), as realized for the English language.

```

// Loop on all words blank separated
repeat
  Posit := Pos( cSpace, MyTerm );
  EndTerm := Posit = 0;
  if ( EndTerm ) then
  begin
    MyCell.Lem := MyTerm;
    MyCell.Wrd := MyTerm;
  end else
  begin
    MyCell.Lem := Copy( MyTerm, 1, Posit - 1 );
    MyCell.Wrd := MyCell.Lem;
    MyTerm := Copy( MyTerm, Posit + 1, Length( MyTerm ) );
  end;

  // Store the cell
  MyCell.Cas := wa_nom;
  MyCell.Typ := wt_adj;
  if ( EndTerm ) then
    MyCell.Typ := wt_nou;
  MyCell.Gnd := gd_undef;
  MyCell.Num := nb_sing;
  Self.Node[ NbWord ] := MyCell;|
  Inc( NbWord );
until ( EndTerm );
Self.IsRegular := True;

```

Figure 23.7: Excerpta of the procedure UnivSetNominativeEN. One can see the repeat loop on all blank separated words. Each word is first extracted from the initial term. Then the grammar cell is computed, all words being adjectives except the last one, in English. Finally the term is declared as regular.

23.7 Log of updates

16 Sep 2025 Full update of this chapter. The source version is now the French version.

13 Mar 2023 Creation of the file.

23.8 Credentials

This document is part of the book *Universal Terminology* accompanying the website on Terminologia Anatomica Humana. It expresses the vision of the authors of the $\mathbf{T}_{logy}$ about the foundations of the science of ontology, supporting the here presented terminology. Despite it is as exact as possible, close to the reality of the database of the terminology and the surrounding software, approximations, errors and ambiguities are possible and should be considered as independent of their willingness and intents.

Identified comments about the content of the website and its presentation are welcome. An appropriate answer will be given when pertinent.

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