ARIANE (GETA) MT System

Presenter: Batuhan Baykara

Outline

1 Historical Background

2 The System

3 Processes and Components

- 3.1 Application Environment
- 3.2 Analysis Process
  - 3.2.1 Morphological Analysis
  - 3.2.2 Structural (Multi-Level) Analysis
- 3.3 Transfer Process
  - 3.3.1 Lexical Transfer
  - 3.3.2 Structural Transfer
- 3.4 Generation Process
  - 3.4.1 Syntactic Generation
  - 3.4.2 Morphological Generation
- 3.5 Rule Writing Formalisms
  - 3.5.1 ATEF
  - 3.5.2 ROBRA

4 Tools Integrated to the System

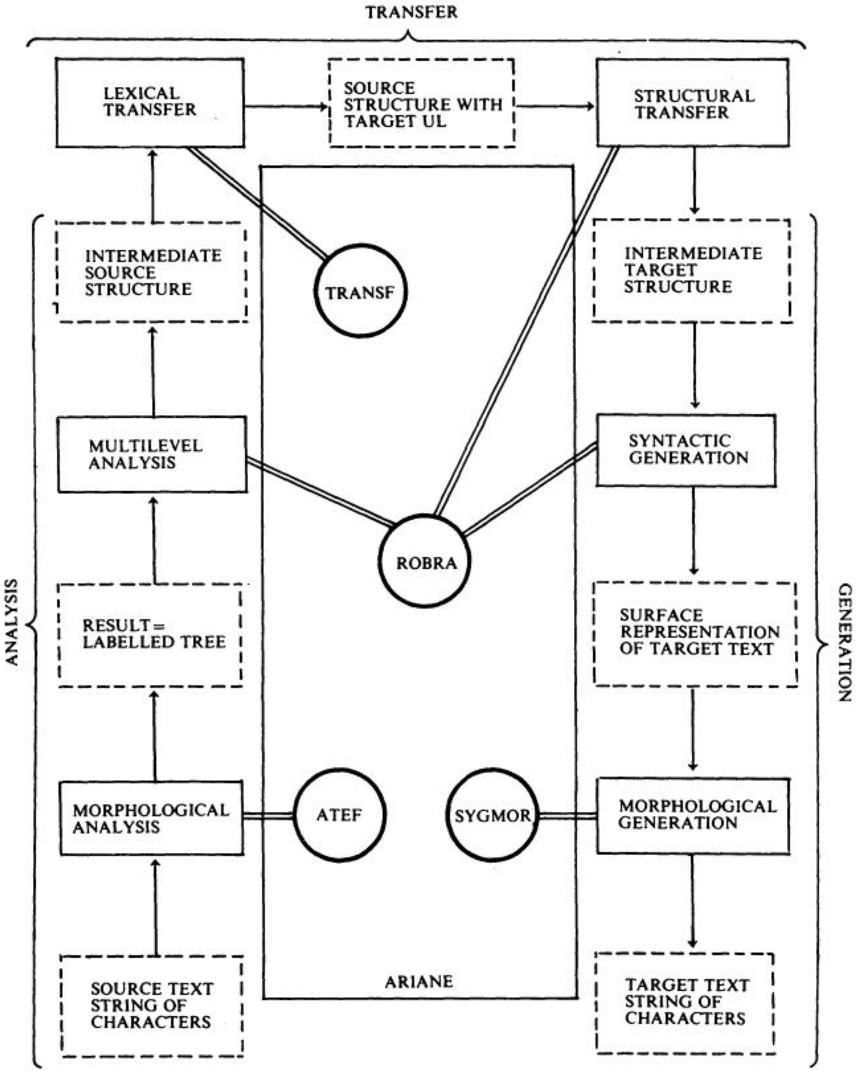
5 Example Translations

Historical Background

- One of most fundamental MT systems
- GETA (Groupe d’Etudes pour la Traduction Automatique) former CETA (Centre d’Etudes pour la Traduction Automatique)
- Led by Bernard Vauquois
- Interlingua systems developed in CETA in 1960s (Russian-French)
- Renamed as GETA and Ariane system (transfer based) developed
- First release in 1978 (Ariane-78)
- Then other systems followed; Ariane-85, Ariane-G5

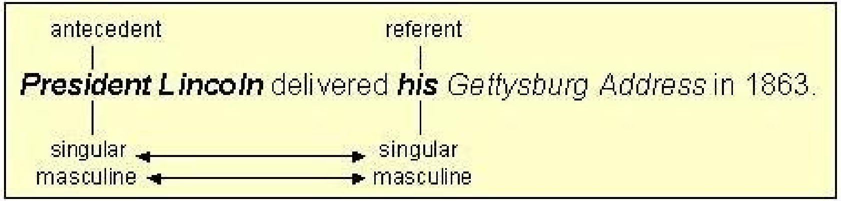
The Overall System

- Main goal: Create a workbench for linguists
- Transfer based system composed of 3 phases;
  - Analysis
  - Transfer
  - Generation
- Very complex system
- Used mostly in Russian-French translation
- But some German-French translations were made
- Other researchers that worked at some point in GETA experimented with English-Malay and English-Thai translations.


TRANSFER
LEXICAL TRANSFER
SOURCE STRUCTURE WITH TARGET UL
STRUCTURAL TRANSFER
INTERMEDIATE SOURCE STRUCTURE
TRANSF
INTERMEDIATE TARGET STRUCTURE
MULTILEVEL ANALYSIS
SYNTACTIC GENERATION
ROBRA
ANALYSIS
RESULT= LABELLED TREE
SURFACE REPRESENTATION OF TARGET TEXT
GENERATION
MORPHOLOGICAL ANALYSIS
ATEF
SYGMOR
MORPHOLOGICAL GENERATION
ARIANE
SOURCE TEXT STRING OF CHARACTERS
TARGET TEXT STRING OF CHARACTERS

Application Process

- Before giving the input to the system, **pre-editing** can be done;
    - It is optional
    - Some problems are solved;
        - Mostly lexical ambiguities are solved
        - The antecedent of a relative pronoun


antecedent
referent
President Lincoln delivered *his Gettysburg Address* in 1863.
singular
masculine
singular
masculine

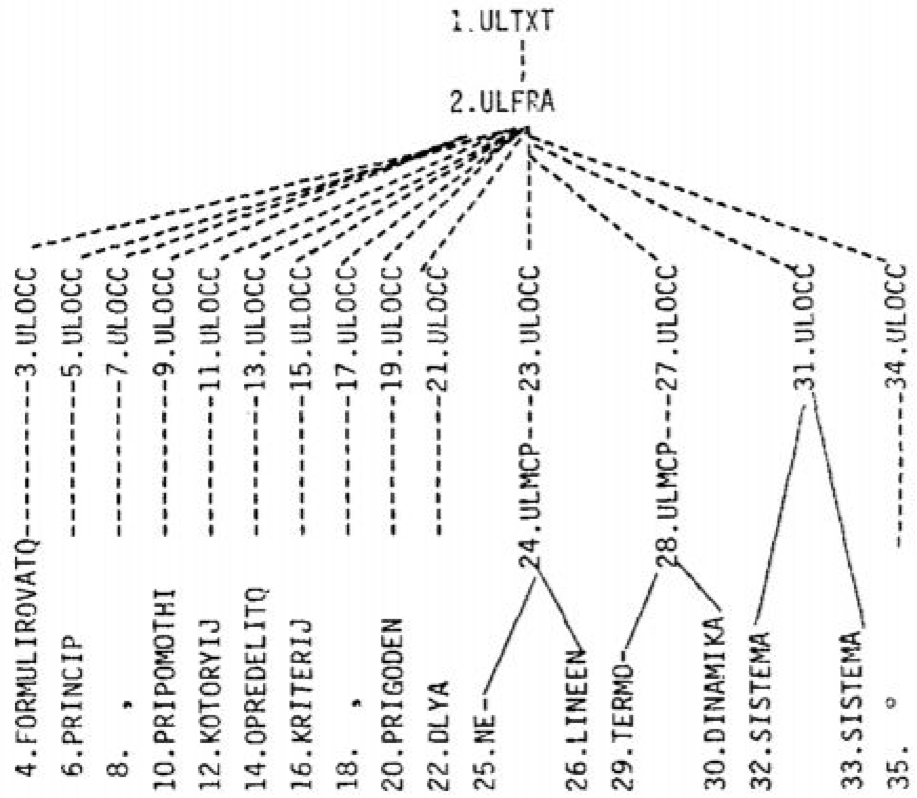
- After the translation is obtained, **post-editing** is possible;
    - This process can increase the quality of the translation significantly
    - It is an expensive process
    - Some sub-environment tools such as THAM are used
- Ariane is a **non-interactive** tool however; in some parts human interruptions may be necessary.
    - Correct spelling errors or make modifications to the dictionary

Analysis Process

- Two steps; morphological analysis and structural analysis.

Mophological Anaylsis

- Process the input according to ATEF formalism
- In the end a flat tree is produced.
- UL= Lexical unit, ULTXT=text, ULFRA= sentence, ULOCC=word
- Last level contains grammatical information..



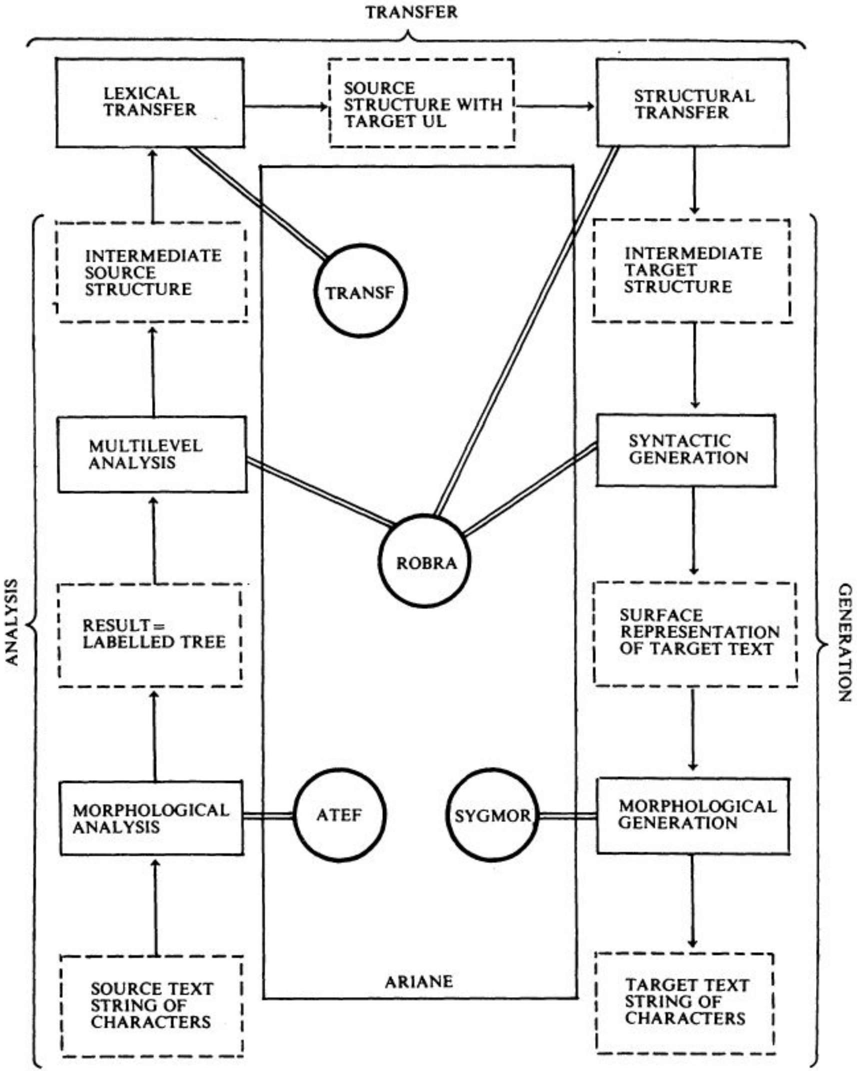
Analysis Process cont...

Structural Analysis (Multi-level Analysis)

- **Most complex and difficult part of the whole translation process**
    - In depth analysis is required to find morphological, lexical and logico-semantic information.
        - Morphological level -> dogs (LU=dog and plural noun)
        - Syntactic level -> finding noun phrases, verb phrases etc..
        - Logico-semantic level -> deep syntactic representation showing dependency relations with their semantic roles (goal, cause, location, gender etc...)
    - The tree should be unambiguous at the end of the analysis process.

Analysis Process cont...

- In syntactic analysis ROBRA rule writing formalism is used.
- ROBRA is a tree-transducer system in the heart of Ariane.
- The system works as follows;
  1) Transformational rules (TR) are written by linguists
  2) These rules are grouped in transformational grammar (TG)
  3) TG is applied to the tree obtained from morphological analysis. Hence all TRs are executed on it
  4) The overall structure is control via a control graph which channels the input to the corresponding TGs.
- Additionally, other problems such as anaphora resolution besides ambiguity can also be resolved depending on the system configurations.


TRANSFER
LEXICAL TRANSFER
SOURCE STRUCTURE WITH TARGET UL
STRUCTURAL TRANSFER
INTERMEDIATE SOURCE STRUCTURE
TRANSF
INTERMEDIATE TARGET STRUCTURE
MULTILEVEL ANALYSIS
SYNTACTIC GENERATION
ROBRA
ANALYSIS
RESULT= LABELLED TREE
SURFACE REPRESENTATION OF TARGET TEXT
GENERATION
MORPHOLOGICAL ANALYSIS
ATEF
SYGMOR
MORPHOLOGICAL GENERATION
ARIANE
SOURCE TEXT STRING OF CHARACTERS
TARGET TEXT STRING OF CHARACTERS

Transfer Process

Transfer phase consists of two steps; lexical transfer and structural transfer.

Lexical Transfer

TRANSF component is used which is a bilingual multichoice dictionary of transfer rules . Takes the tree as an input and changes the labellings on the tree according to rules; it is like a pattern matcher.

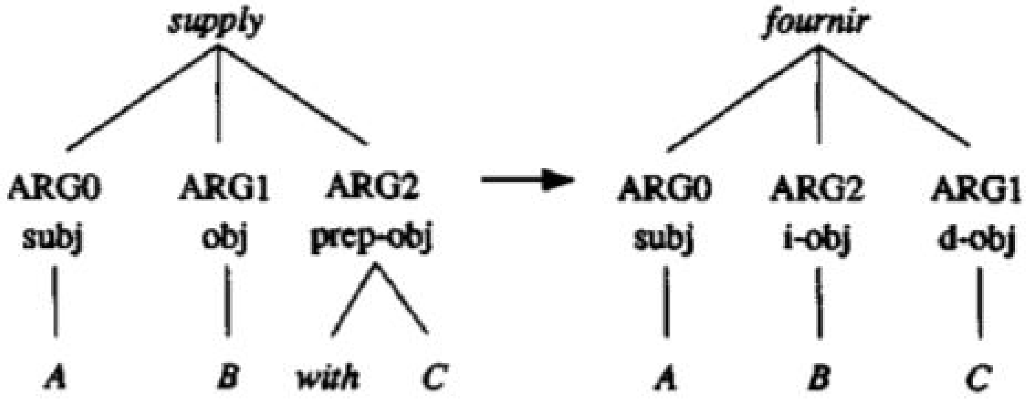
- **Simple-to-simple substitution**: Directly translates the source lexical unit to the corresponding target lexical unit (one-to-one translation).
- **Simple-to-complex substitution:** A single source unit is translated into several target lexical units. For example, “avec” is translated as “by means of”.
- **Complex-to-simple or complex-to-complex substitution:** Multiple lexical units are translated as a single unit or multiple units.

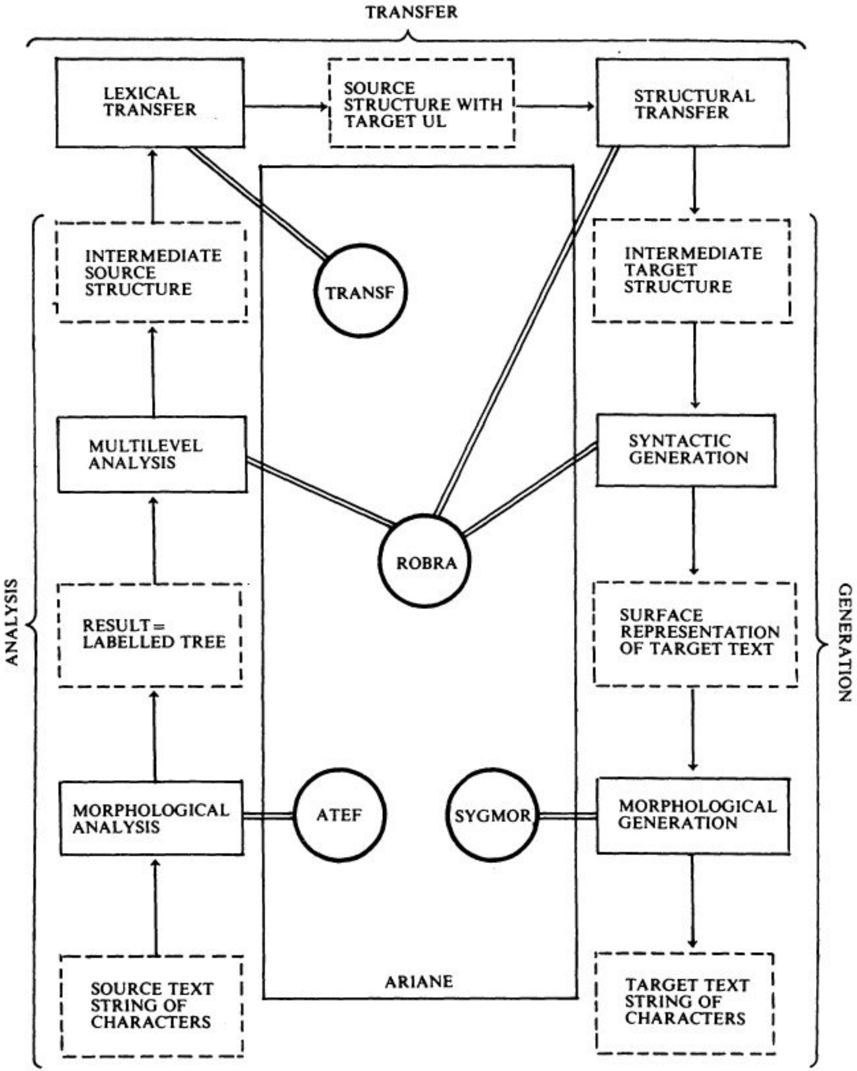
Transfer Process cont...

Structural Transfer

- ROBRA is used at this step.
- Reconstruction of the source tree to the target tree structure is handled at this step.
- In this step, necessary alterations such as inserting or deleting is done.

(7) A supplies B with C → *A fournit C à B*




TRANSFER
LEXICAL TRANSFER
SOURCE STRUCTURE WITH TARGET UL
STRUCTURAL TRANSFER
INTERMEDIATE SOURCE STRUCTURE
TRANSF
INTERMEDIATE TARGET STRUCTURE
MULTILEVEL ANALYSIS
SYNTACTIC GENERATION
ROBRA
ANALYSIS
RESULT= LABELLED TREE
SURFACE REPRESENTATION OF TARGET TEXT
GENERATION
MORPHOLOGICAL ANALYSIS
ATEF
SYGMOR
MORPHOLOGICAL GENERATION
SOURCE TEXT STRING OF CHARACTERS
ARIANE
TARGET TEXT STRING OF CHARACTERS

Generation Process

The process consists of two steps; syntactic generation and morphological generation.

Syntactic Generation

- Takes the output obtained from transfer phase
- Computes the final surface syntactic structure
- Includes selection of appropriate verbal auxiliaries, rearrangement of word order and setting values of morphological variable values such as sumber and gender agreements.
- Again ROBRA is used

Generation Process cont...

Morphological Generation

- This is the last step of the translation system
- The output text is generated from the surface representation
- SYGMOR module is used
  - It is a rule writing formalism
  - Its function is to convert labelled tree structure in to string format including punctuations.
  - It can be thought of as a decoder.

Rule Writing Formalisms

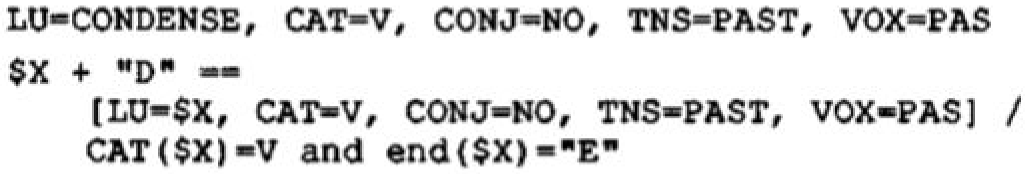
Ariane uses four different software packages which assist in the development of various phases.

- **ATEF**: String to tree transformation package used in **Analysis phase**
- **ROBRA**: Tree to tree transformation package used in **all phases**
- **TRANSF**: Tree to tree transformation package used in **Transfer phase**
- **SYGMOR**: Tree to string transformation module used in **Generation phase**

Rule Writing Formalisms cont...

ATEF

- ATEF aims to handle the mappings of strings and convert them into a bunch of feature that are represented in as structured tree format.



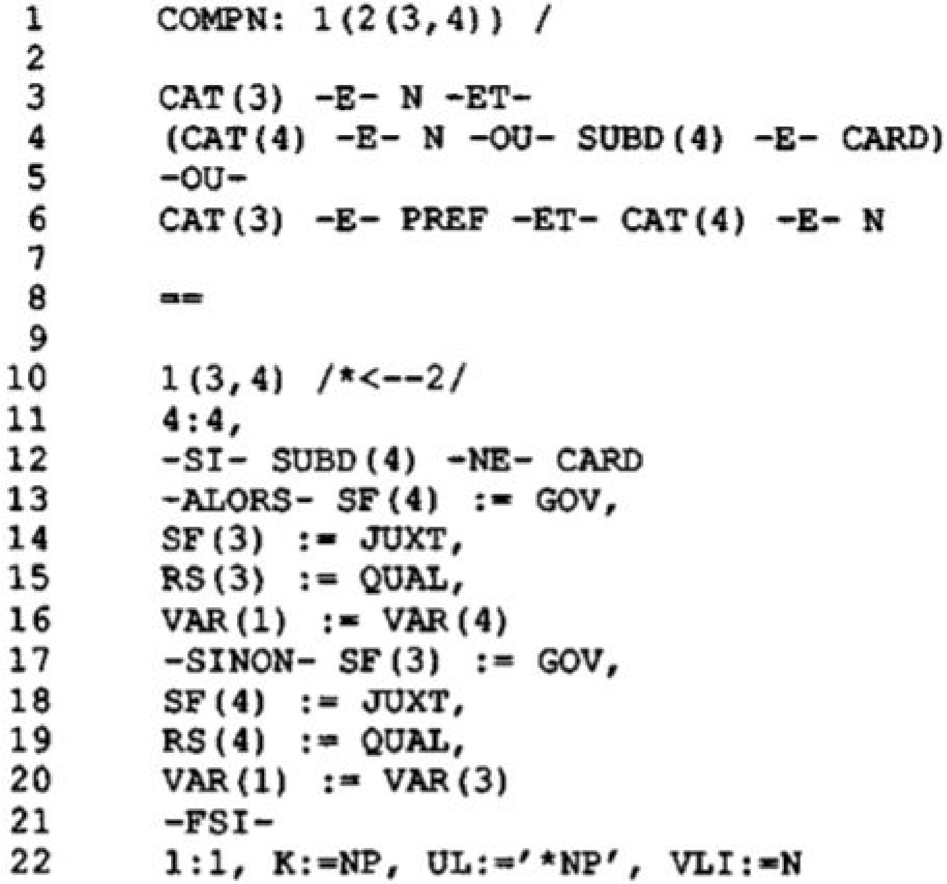
```
LU=CONDENSE, CAT=V, CONJ=NO, TNS=PAST, VOX=PAS
$X + "D" ==
    [LU=$X, CAT=V, CONJ=NO, TNS=PAST, VOX=PAS] /
    CAT($X)=V and end($X)="E"
```

- $X is a variable that ends with e and is in the lexicon category of of verb (V).
- ATEF uses dictionary lookups to find the morphs.

Rule Writing Formalisms

ROBRA

- An example Transformational rule (TR) for compound nouns.
- -E- => equal
- -ET- => and
- -OU- => or
- -SI- =>if
- -NE- => not equal
- -ALORS- => then
- -SINON- => else
- -FSI- => end if



```
COMPN: 1(2(3,4)) /

CAT(3) -E- N -ET-
(CAT(4) -E- N -OU- SUBD(4) -E- CARD)
-OU-
CAT(3) -E- PREF -ET- CAT(4) -E- N

==

1(3,4) /*<--2/
4:4,
-SI- SUBD(4) -NE- CARD
-ALORS- SF(4) := GOV,
SF(3) := JUXT,
RS(3) := QUAL,
VAR(1) := VAR(4)
-SINON- SF(3) := GOV,
SF(4) := JUXT,
RS(4) := QUAL,
VAR(1) := VAR(3)
-FSI-
1:1, K:=NP, UL:='*NP', VLI:=N
```

Tools integrated to the System

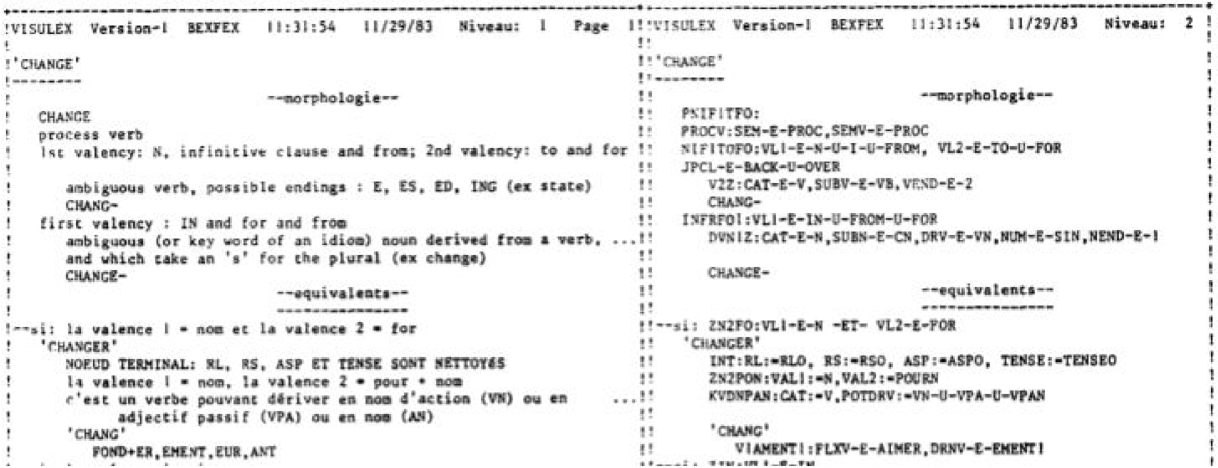
- Ariane is designed to be a product therefore it needs to be working on all kinds of MT tasks.
- Some end-users,linguists, have requested extensions to the system.

ATLAS: A helper tool where linguist can add new words and rules to the dictionaries.

THAM: It is a text editor that can assist the linguist in the process of translation. It provides a dictionary which can be directly accesed from the screen. Importantly it provides a set of unctions that are programmed which help lingusit in terms of efficiency.

Tools integrated to the System

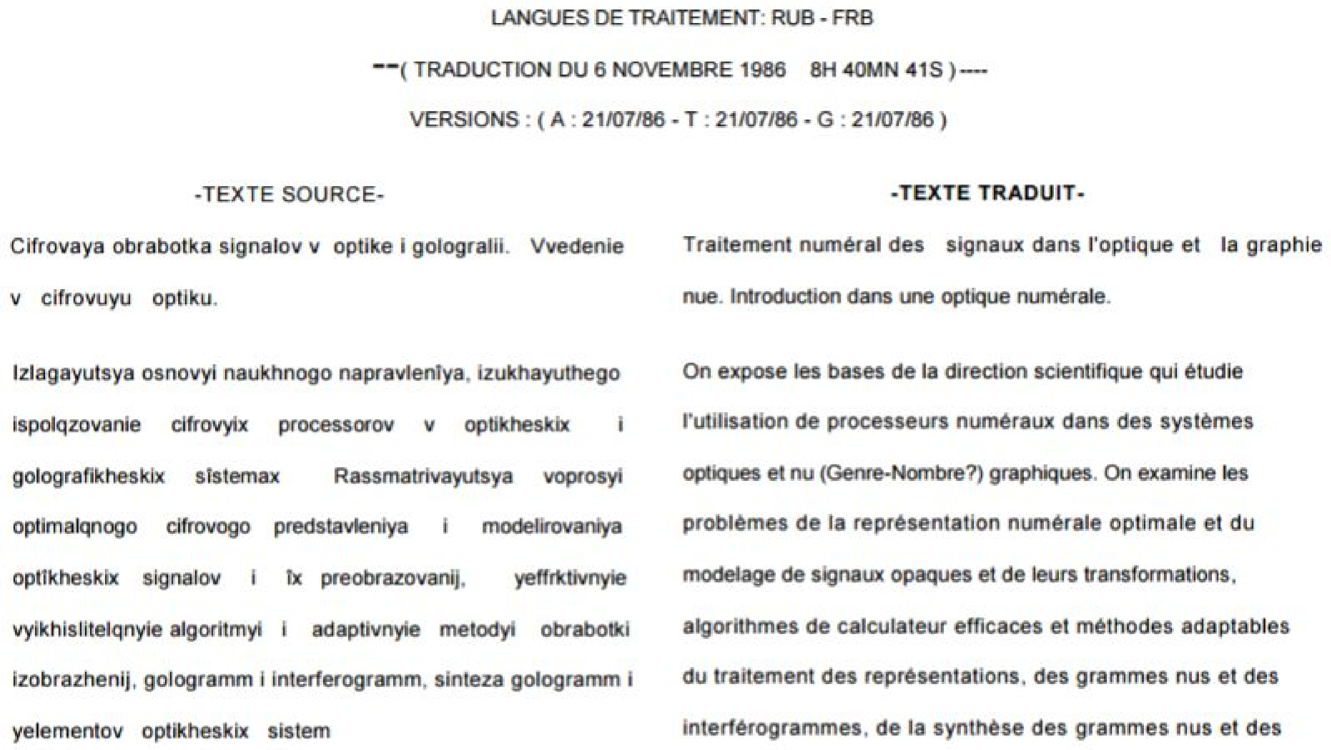
VISULEX: It is an easy to use visualization tool for assembling and separating essential information in the linguistic database. For instance, lexical database of Ariane is kept in more than 50 files, it is scattered all around. Hence, visulex makes it easier to access and see the lexical units.



```
+--------------------------------------------------------------------------+-----------------------------------------------------------------------+
!VISULEX  Version-1  BEXFEX   11:31:54   11/29/83   Niveau:  1    Page  !!'VISULEX  Version-1  BEXFEX   11:31:54   11/29/83   Niveau:  2 !
!                                                                       !!                                                                  !
!'CHANGE'                                                               !!'CHANGE'                                                          !
!--------                                                               !!---------                                                         !
!                          --morphologie--                              !!                          --morphologie--                         !
!   CHANGE                                                              !!   PSIFITFO:                                                      !
!   process verb                                                        !!   PROCV:SEM-E-PROC,SEMV-E-PROC                                   !
!   1st valency: N, infinitive clause and from; 2nd valency: to and for !!   NIFITOFO:VL1-E-N-U-I-U-FROM, VL2-E-TO-U-FOR                   !
!                                                                       !!   JPCL-E-BACK-U-OVER                                             !
!      ambiguous verb, possible endings : E, ES, ED, ING (ex state)     !!      V22:CAT-E-V,SUBV-E-VB,VEND-E-2                              !
!      CHANG-                                                           !!      CHANG-                                                      !
!   first valency : IN and for and from                                 !!   INFRFO1:VL1-E-IN-U-FROM-U-FOR                                  !
!      ambiguous (or key word of an idiom) noun derived from a verb, ...!!      DVN1Z:CAT-E-N,SUBN-E-CN,DRV-E-VN,NUM-E-SIN,NEND-E-1         !
!      and which take an 's' for the plural (ex change)                 !!                                                                  !
!      CHANGE-                                                          !!      CHANGE-                                                     !
!                           --equivalents--                             !!                          --equivalents--                         !
!                           ---------------                             !!                          ---------------                         !
!--si: la valence 1 = nom et la valence 2 = for                         !!--si: ZN2FO:VL1-E-N -ET- VL2-E-FOR                                !
!   'CHANGER'                                                           !!   'CHANGER'                                                      !
!      NOEUD TERMINAL: RL, RS, ASP ET TENSE SONT NETTOYéS               !!      INT:RL:=RLO, RS:=RSO, ASP:=ASPO, TENSE:=TENSEO              !
!      la valence 1 = nom, la valence 2 = pour + nom                    !!      ZN2PON:VAL1:=N,VAL2:=POURN                                  !
!      c'est un verbe pouvant dériver en nom d'action (VN) ou en     ...!!      KVDNPAN:CAT:=V,POTDRV:=VN-U-VPA-U-VPAN                      !
!           adjectif passif (VPA) ou en nom (AN)                        !!                                                                  !
!      'CHANG'                                                          !!      'CHANG'                                                     !
!         FOND+ER,EMENT,EUR,ANT                                         !!         V1AMENT1:FLXV-E-AIMER,DRNV-E-EMENT1                      !
```

Example Translations

- Ariane is mostly used in Russian-French,
- Tested on real world text
- Dictionaries used contains 7500 lexical units
  - 5000 in French
  - 2500 Russian
- The translations were made on an IBM mainframe.
- A total of 835 abstract and text were translated.
- Results were presented to the Ministry of Defence



LANGUES DE TRAITEMENT: RUB - FRB

--(TRADUCTION DU 6 NOVEMBRE 1986 8H 40MN 41S)----

VERSIONS : (A : 21/07/86 - T : 21/07/86 - G : 21/07/86)

-TEXTE SOURCE-

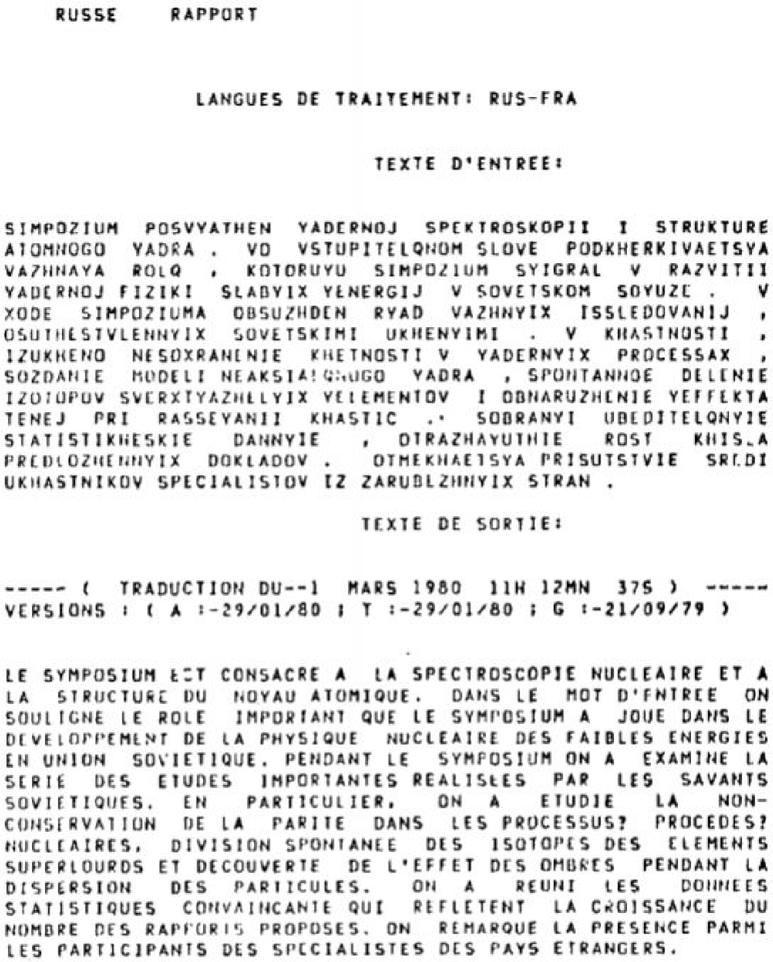
Cifrovaya obrabotka signalov v optike i gologralii. Vvedenie v cifrovuyu optiku.

Izlagayutsya osnovyi naukhnogo napravlenîya, izukhayuthego ispolqzovanie cifrovyix processorov v optikheskix i golografikheskix sîstemax Rassmatrivayutsya voprosyi optimalqnogo cifrovogo predstavleniya i modelirovaniya optîkheskix signalov i îx preobrazovanij, yeffrktivnyie vyikhislitelqnyie algoritmyi i adaptivnyie metodyi obrabotki izobrazhenij, gologramm i interferogramm, sinteza gologramm i yelementov optikheskix sistem

-TEXTE TRADUIT-

Traitement numéral des signaux dans l'optique et la graphie nue. Introduction dans une optique numérale.

On expose les bases de la direction scientifique qui étudie l'utilisation de processeurs numéraux dans des systèmes optiques et nu (Genre-Nombre?) graphiques. On examine les problèmes de la représentation numérale optimale et du modelage de signaux opaques et de leurs transformations, algorithmes de calculateur efficaces et méthodes adaptables du traitement des représentations, des grammes nus et des interférogrammes, de la synthèse des grammes nus et des



```
     RUSSE    RAPPORT


                    LANGUES DE TRAITEMENT: RUS-FRA

                                        TEXTE D'ENTREE:


SIMPOZIUM  POSVYATHEN  YADERNOJ  SPEKTROSKOPII  I  STRUKTURE
ATOMNOGO  YADRA .  VO  VSTUPITELQNOM SLOVE  PODKHERKIVAETSYA
VAZHNAYA  ROLQ  ,  KOTORUYU  SIMPOZIUM  SYIGRAL  V  RAZVITII
YADERNOJ FIZIKI  SLABYIX YENERGIJ  V SOVETSKOM  SOYUZE .   V
XODE  SIMPOZIUMA  OBSUZHDEN  RYAD  VAZHNYIX  ISSLEDOVANIJ  ,
OSUTHESTVLENNYIX  SOVETSKIMI  UKHENYIMI  .  V  KHASTNOSTI  ,
IZUKHENO  NESOXRANENIE  KHETNOSTI V  YADERNYIX  PROCESSAX  ,
SOZDANIE  MODELI NEAKSIA!Q.UGO  YADRA  , SPONTANNOE  DELENIE
IZOTOPOV SVERXTYAZHELYIX YELEMENTOV  I OBNARUZHENIE YEFFEKTA
TENEJ  PRI  RASSEYANII  KHASTIC  .·  SOBRANYI  UBEDITELQNYIE
STATISTIKHESKIE   DANNYIE   ,  OTRAZHAYUTHIE   ROST   KHIS_A
PREDLOZHENNYIX  DOKLADOV .   OTMEKHAETSYA PRISUTSTVIE  SREDI
UKHASTNIKOV SPECIALISTOV IZ ZARUBEZHNYIX STRAN .

                                       TEXTE DE SORTIE:


----- (  TRADUCTION DU--1  MARS 1980  11H 12MN  37S )  -----
VERSIONS : ( A :-29/01/80 ; T :-29/01/80 ; G :-21/09/79 )


LE SYMPOSIUM EST CONSACRE A  LA SPECTROSCOPIE NUCLEAIRE ET A
LA  STRUCTURE DU  NOYAU ATOMIQUE.  DANS LE  MOT D'ENTREE  ON
SOULIGNE LE ROLE  IMPORTANT QUE LE SYMPOSIUM A  JOUE DANS LE
DEVELOPPEMENT DE LA PHYSIQUE  NUCLEAIRE DES FAIBLES ENERGIES
EN UNION  SOVIETIQUE. PENDANT LE  SYMPOSIUM ON A  EXAMINE LA
SERIE  DES  ETUDES  IMPORTANTES REALISEES  PAR  LES  SAVANTS
SOVIETIQUES.  EN   PARTICULIER,   ON  A   ETUDIE   LA   NON-
CONSERVATION  DE LA  PARITE  DANS  LES PROCESSUS?  PROCEDES?
NUCLEAIRES,  DIVISION SPONTANEE  DES  ISOTOPES DES  ELEMENTS
SUPERLOURDS ET DECOUVERTE  DE L'EFFET DES OMBRES  PENDANT LA
DISPERSION   DES  PARTICULES.   ON   A   REUNI   LES   DONNEES
STATISTIQUES  CONVAINCANTE QUI  REFLETENT  LA CROISSANCE  DU
NOMBRE DES RAPPORTS PROPOSES. ON  REMARQUE LA PRESENCE PARMI
LES PARTICIPANTS DES SPECIALISTES DES PAYS ETRANGERS.
```

Thank you for listening…