Text-to-pictograph conversion and vice versa

Language Engineering Applications

Vincent Vandeghinste

joint work with Leen Sevens, Ineke Schuurman, Frank Van Eynde, Magali Norré

Content

- Introduction
- Text-to-pictograph conversion
- Pictograph-to-text conversion
- Conclusions

INTRODUCTION

Augmentative and Alternative Communication (AAC)

- Assist people that are suffering from **cognitive disabilities**
- Allow them to **independently** use the Internet
- Increase life quality by **reducing social isolation**
- Picture-based communication systems are a form of AAC technology

Picture-based communication

- Between two and five million people in EU
- Acute need for picture-based communication interfaces that enable social contact
- Interfaces should be
  - easy to use
  - configurable
  - flexible
- Enables illiterate and pre-literate users to communicate

WAI-NOT Platform

- Enabling internet access for people with mental disabilities
- Specific applications for these users
  - Chat and e-mail client with the text2picto engine
  - Forum
  - News with text-to-speech
  - Games
- www.wai-not.be (in Dutch)

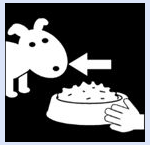
  System is used in
    - Chat
    - Email client

Pictograph sets

Sclera pictographs

hond (dog)

ik (I)



hond-eten-geven
(dog-food-give)

afwas-proper-terugbrengen
(dishes-clean-return)

Beta pictographs

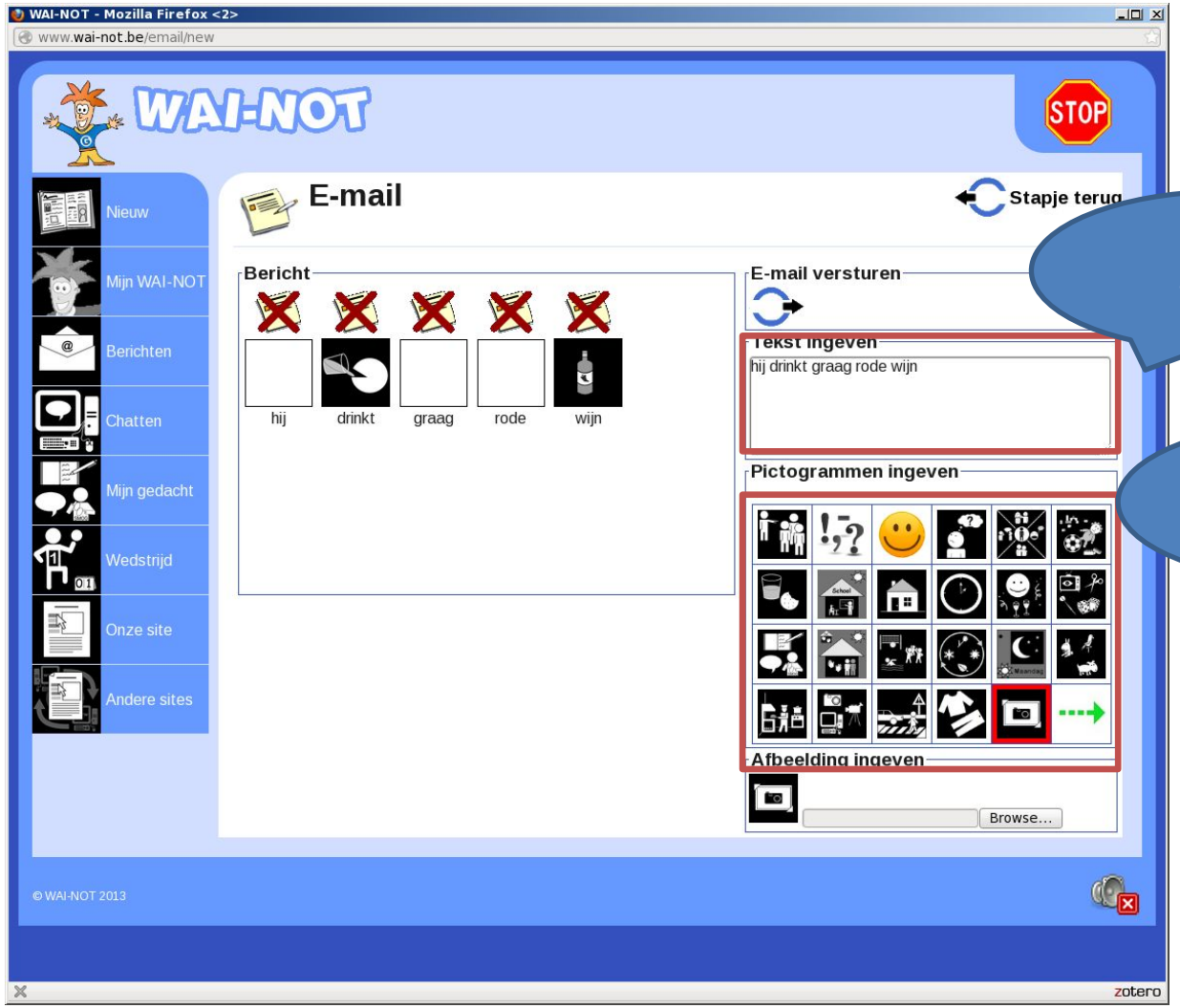
hond (dog)

ik (I)

fruit-persen
(fruit squeeze)

gebraden-kip
(roasted-chicken)

Input methods



text input

pictograph input

TEXT-TO-PICTOGRAPH CONVERSION

Version 1.0

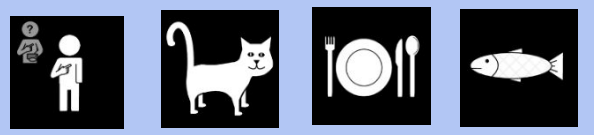
Vincent Vandeghinste, Ineke Schuurman, Leen Sevens and Frank Van Eynde (2015). Translating Text into Pictographs. *Natural Language Engineering*, Cambridge University Press. DOI: http://dx.doi.org/10.1017/S135132491500039X

Example message

Text

Mijn kat eet vis.
(My cat eats fish.)

Sequence of pictographs



Sclera

Beta

WAI-NOT email corpus

- About 70.000 e-mail messages sent with WAI-NOT
- Average length of 7.7 words / e-mail
- Three types of messages
  - e-mails written be literate people (teachers, parents…)
    - broad vocabulary
    - hardest to translate
  - Short messages by the intended users (largest part)
    - mainly only one sentence
    - no punctuation
    - no capitalization
    - several spelling errors
  - Noisy messages
    - random (?) clicking on pictographs

Test sets

- Not from noisy messages
- Development set
  - 186 messages
  - used to test the system
  - used to tune the system parameters
- Evaluation set
  - 50 messages
  - Average length: 20 words

Example message

hij is genezen (he has recovered)

How would you do it?

Given:

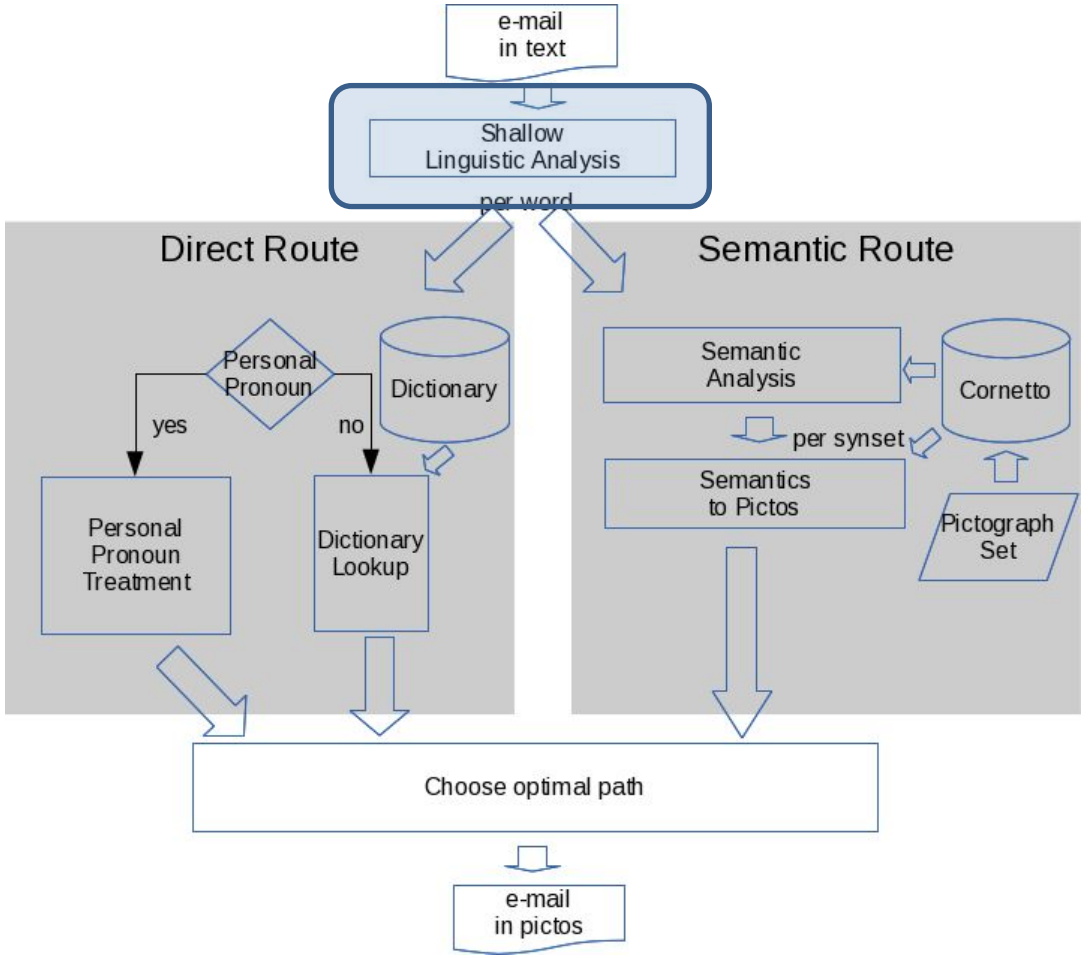
- A set of pre-defined pictographs, such as Sclera

  (Filenames are sometimes indicative of the content of the pictograph)
- A corpus of 70K emails of messages sent with version 0.1

Watch out for:

- Homonymy
- Low coverage

System Description

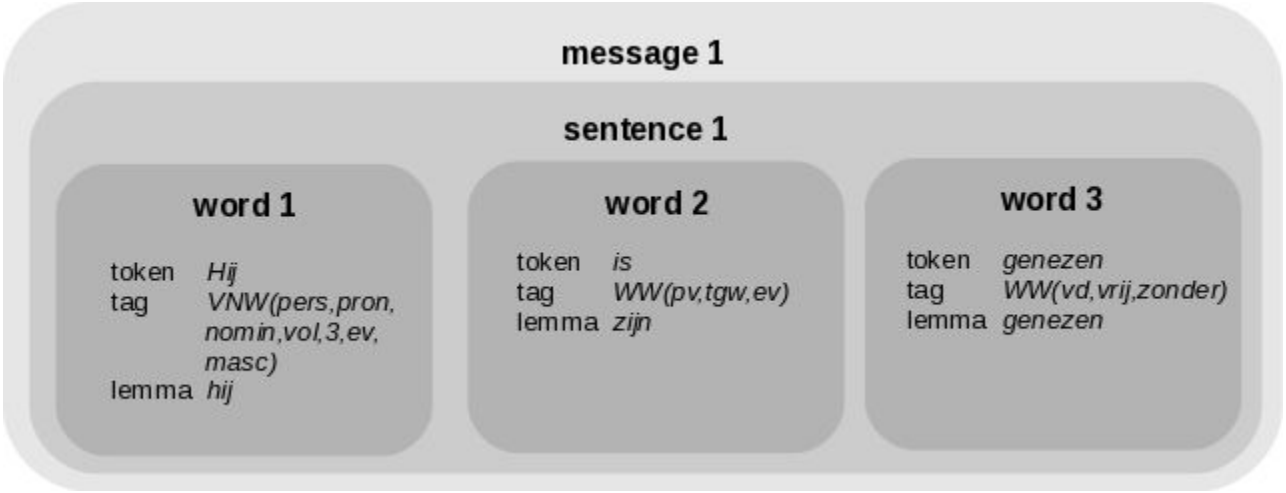


Shallow Linguistic Analysis

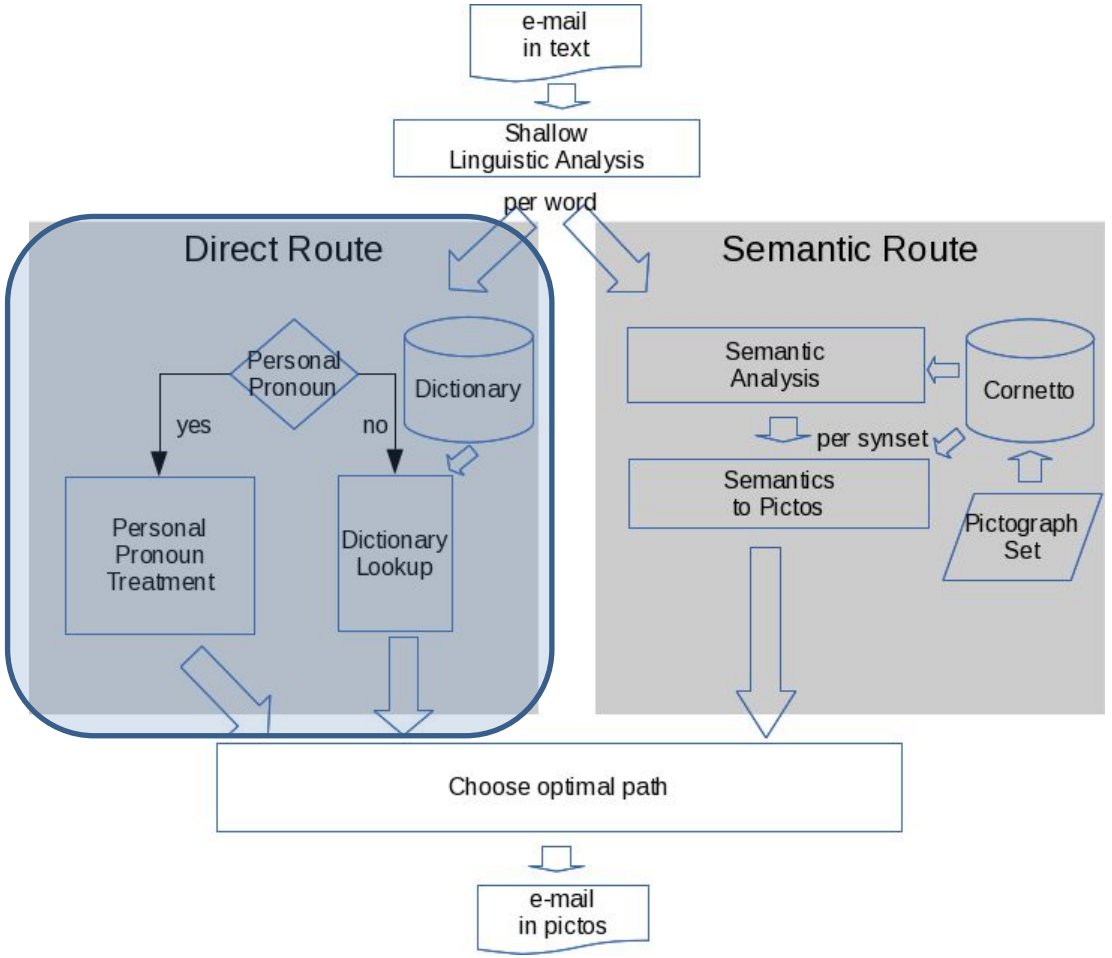
- Tokenization

  splitting off all punctuation apart from hyphen/dash
- Basic Spelling correction
- Part-of-Speech tagging
- Sentence detection
- Separable Verb Detection

Example after SLA



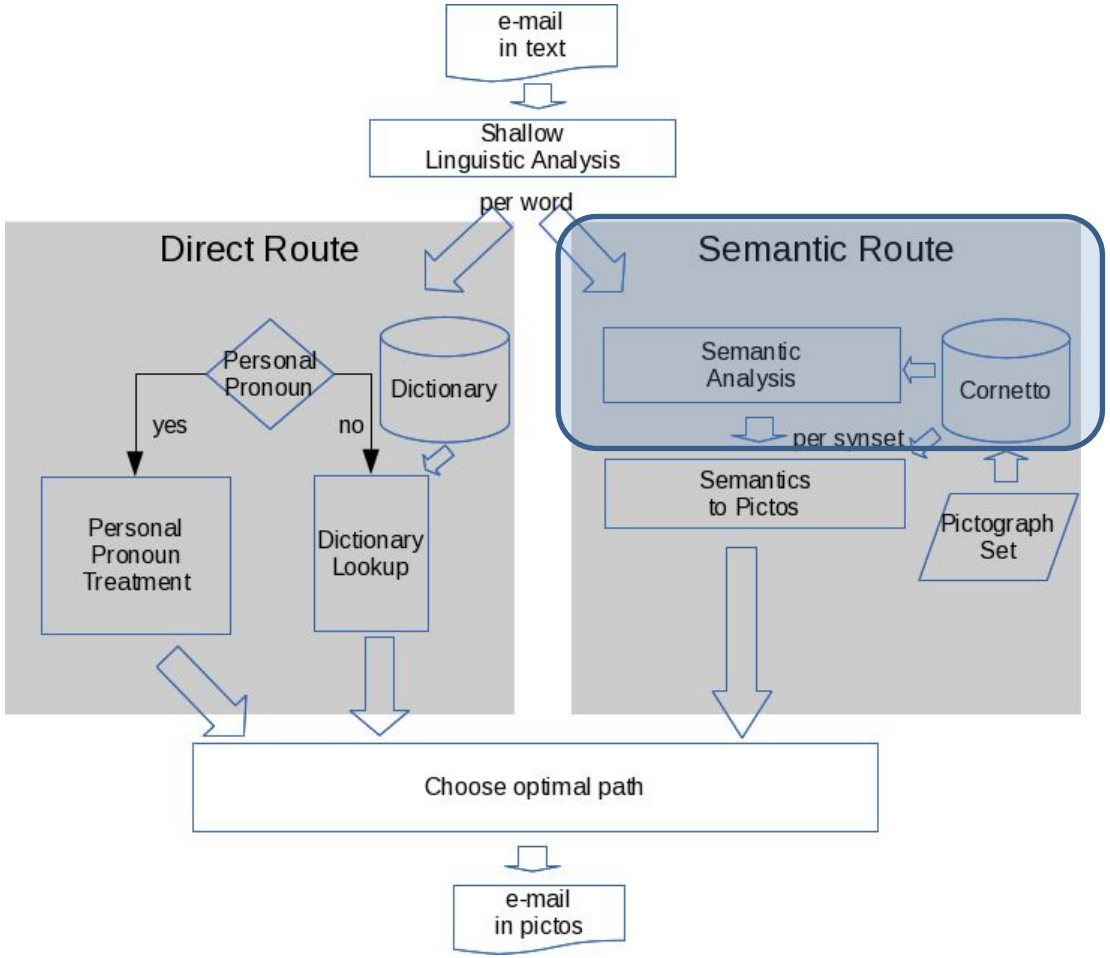
System Description



The direct route

- Not all words should be converted into pictographs
- Not all words can be analyzed with Cornetto (cf. later)
  - **Personal pronouns** are very frequent in e-mail messages and are not included in Cornetto: explicit treatment
  - **Translation mechanism** that uses a dictionary
    - Token / pos-tag / lemma → picto
    - Dictionary entries are based on the most frequent words in the e-mail corpus ($F > 50$) which could not be converted with the semantic route

System Description

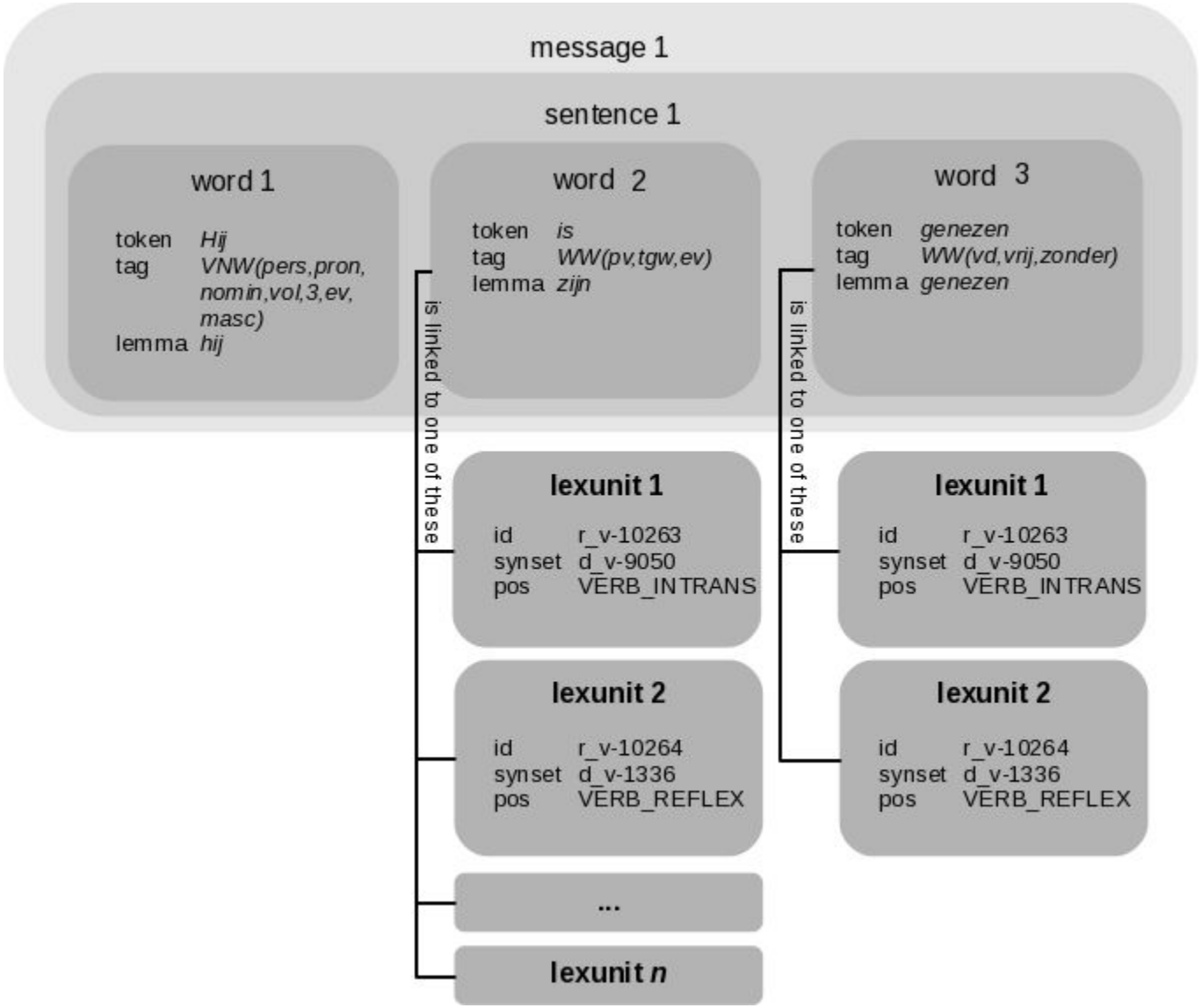


Semantic analysis

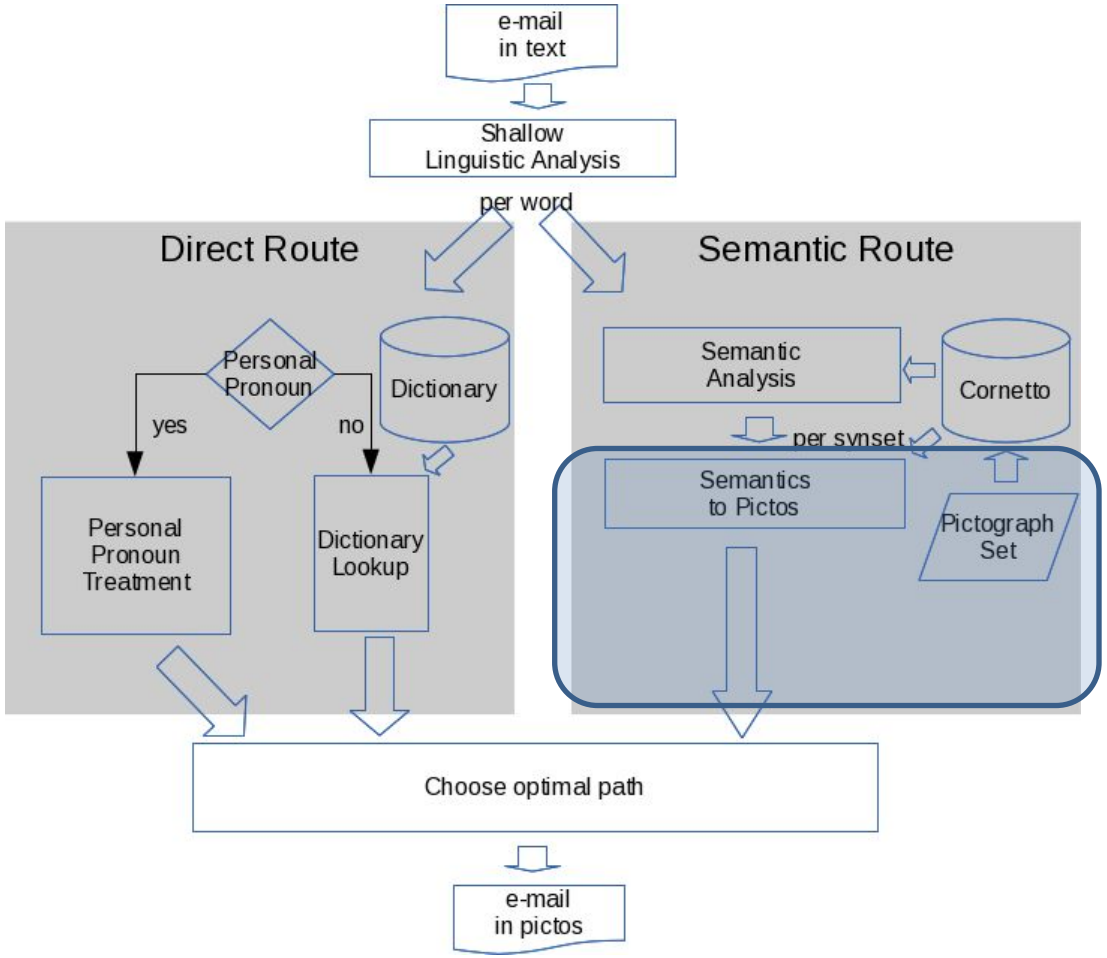
- Detect words indicating **negative** polarity
  - *geen:* look for the head
  - *niet:* look for a verb within a window size of three (preceding and following)
  - Set head feature polarity='negative'
- Lookup Cornetto-**synsets** connected to the lemma of each word
- Not yet using word sense disambiguation, but most common sense based on DutchSemCor

Piek Vossen, Attila Görög, Ruben Izquierdo, and Antal Van den Bosch (2010). DutchSemCor: Targeting the ideal sense-tagged corpus. In: *Proceedings of the 8th International Conference on Language Resources and Evaluation* (LREC), Istanbul, Turkey.

Example after semantic analysis



System Description



Using the links

- Simplex pictographs: linked to a single synset
- Complex pictographs: linked to multiple synsets
  - Head synset
  - Dependent synsets

HEAD: feed
DEPENDENT: dog

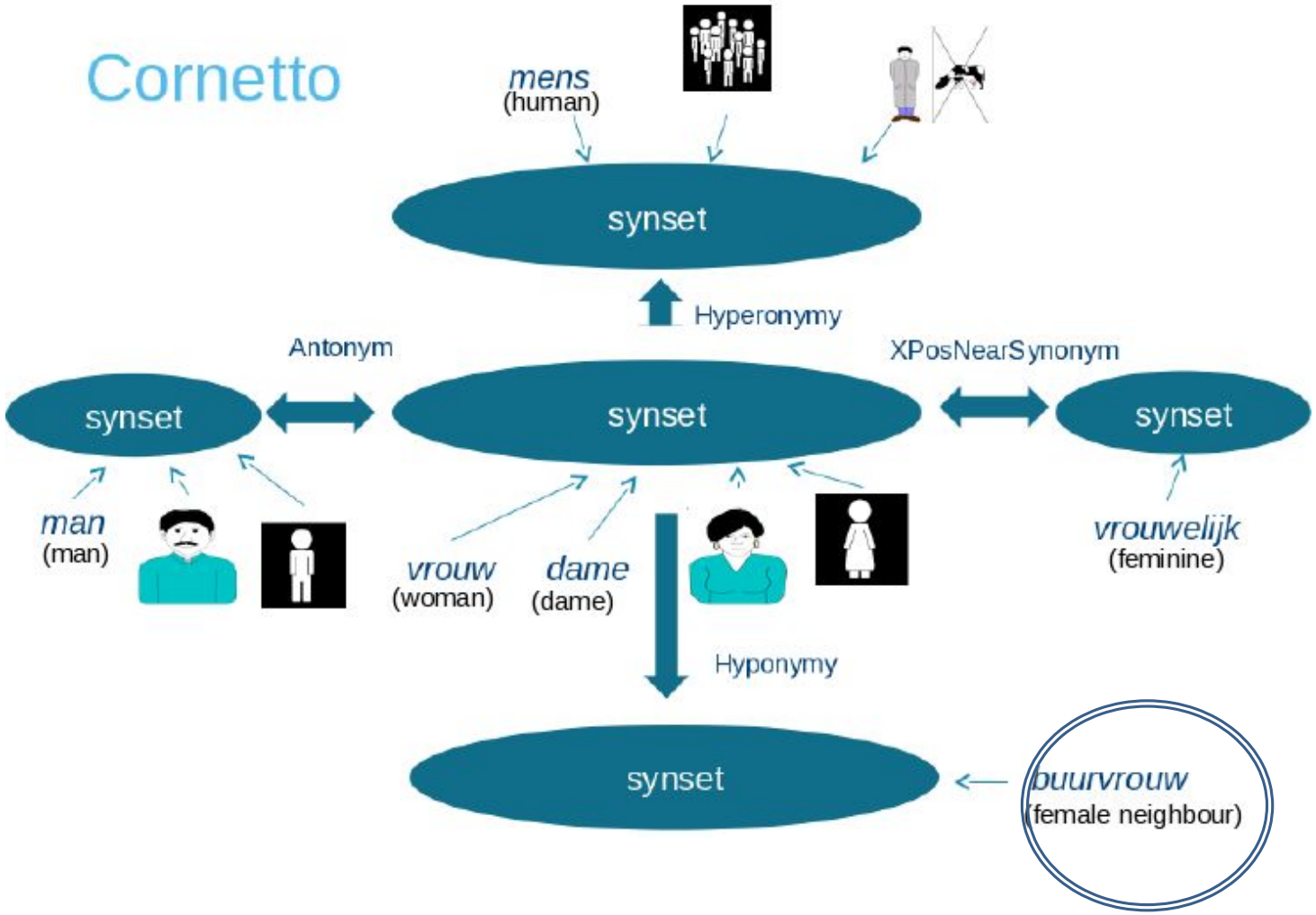
- Extend coverage of the links through the Cornetto relations (penalties)
  - Hyperonymy
  - XPOS synonym
  - Antonym + 

Distribution of number of synsets per pictograph

Nr of synsets	Distribution for Sclera	Distribution for Beta
1	2689	2690
2	2416	16
3	559	
4	42	
5	3	
6	1	
Total	5710	2706

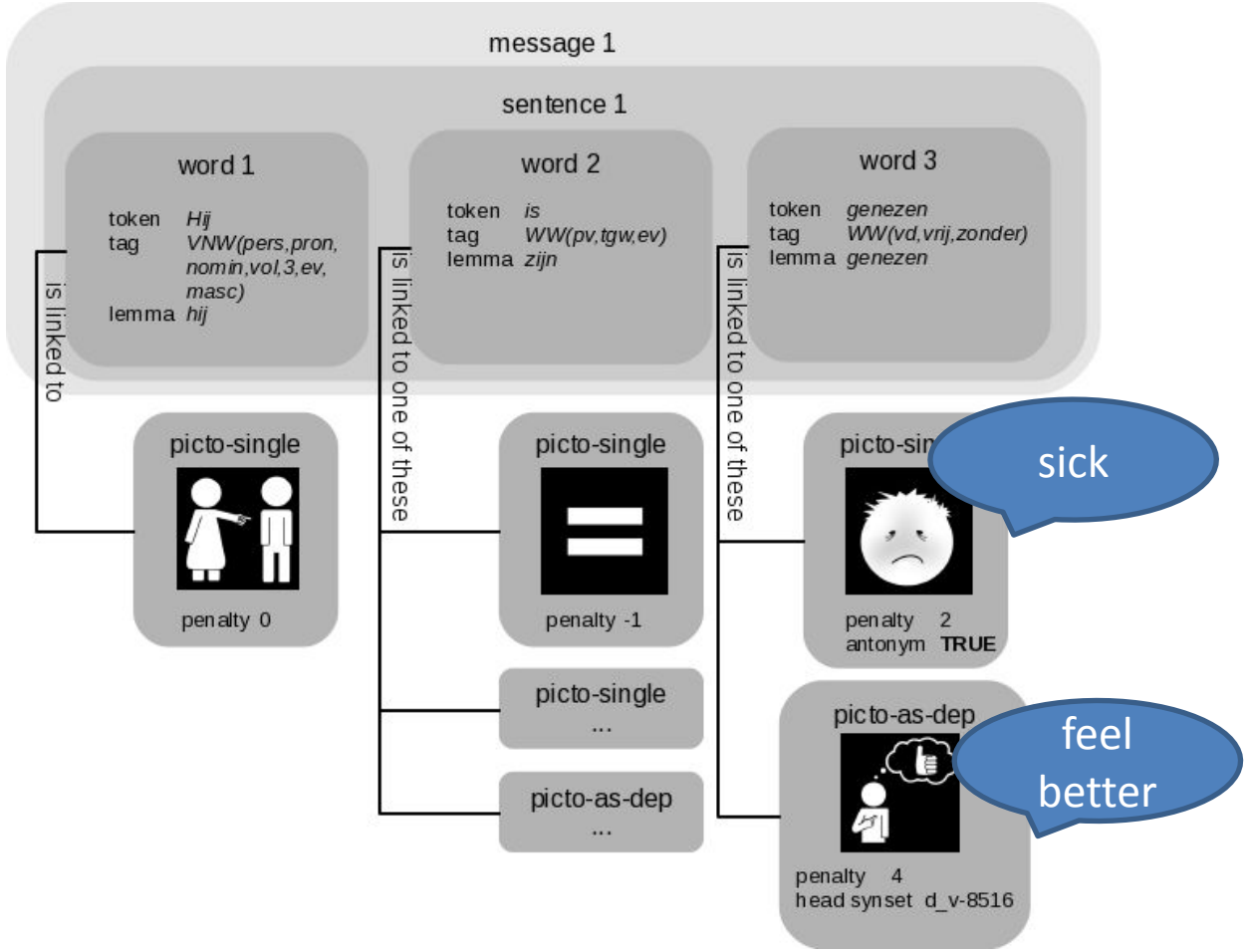
47% is linked to a single synset

99% is linked to a single synset

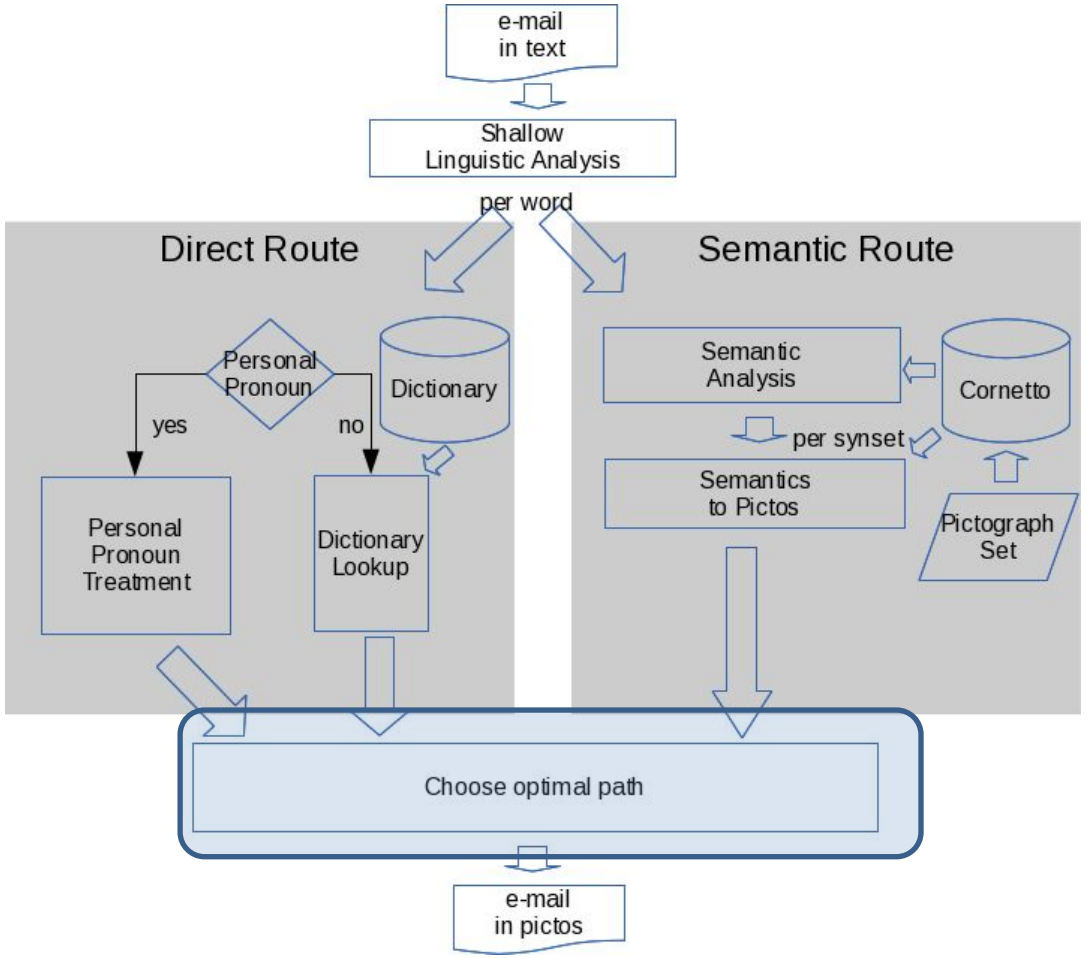


buurvrouw has no picto → find picto through **hyperonymy** → display 

Example after pictograph linking



System Description



Finding the optimal path

- A* search algorithm

$$W(P) = \sum_{i=0}^{n} \sum_{j=0}^{q} W(s_{j_{w_i}})$$

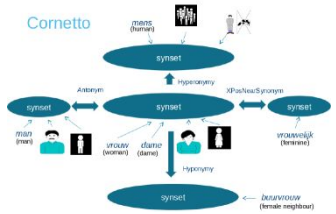
  - W(P) is the weight of a path P
  - n is number of words
  - w_i is the i^{th} word
  - q is the number of pictographs associated with w_i
  - s_{jwi} is the j^{th} pictograph associated with w_i
  - if q=0, we set q=1 and $s_{jwi} = w_i$

Parameter Tuning

- Three types of parameters
- Parameter tuning approach

Three types of parameters

- **Cornetto relations**: using relations increases the distance between the textual and the pictographic message, so we use a series of penalty parameters that determine the cost of these relations
  - Maximum penalty threshold
  - Hyperonym penalty
  - XPos synonymy penalty
  - Antonymy penalty



- **Pictograph features**: determine system behavior with respect to pictograph features: Some pictographs clearly describe **plural** or **singular** concepts
  - Wrong number parameter: penalty for using the wrong number of pictos with number feature
  - No number: penalty for number underspecification in picto or in word
- **Route preference**
  - Out-of-vocabulary parameter determines the cost of leaving a word untranslated
  - Direct route advantage is a bonus for using the direct route over the semantic route

Parameter Tuning

- Determine the optimal set of parameters
- Local hill climbing algorithm
  - Start with random feature values (within certain boundaries)
  - Evaluate translation quality
  - Change one parameter with one step
  - Reevaluate:
    - If improved, keep on changing the same parameter
    - If worse, go back to best scoring set and change a different parameter
  - Until convergence
- Keep track of n best scoring parameter sets to backtrack to
- Evaluation against a development test set of 50 sentences
  - Manually translated into Sclera and Beta
  - Maximize on BLEU score
- Five hill climbing trials with random initializations

Evaluation Test Set

- 84 sentences: 980 words
- 1 reference translation in Sclera, 1 in Beta
- Translation with focus on content and how this content can best be expressed in pictographs
- Not word-by-word translations
- Not post-editing system output

Automatic evaluation

- Progressively activating features of the system (opposite of *ablation*)
  Baseline
  + lemmatization and pos-tagging
  + direct route (including specific pronoun treatment)
  + synonym sets, using Cornetto
  + synset relations
- Evaluated using
  - BLEU: most used MT metric, precision based
  - NIST: similar to BLEU, but less credit to high-frequency non-informative n-grams
  - WER: word error rate
  - PER: position independent word error rate
- Three variants:
  - no spelling correction
  - automated spelling correction
  - manual spelling correction

Results

	No spelling correction				Automated spelling correction				Manual spelling correction			
Condition	**BLEU↑**	**NIST↑**	**WER↓**	**PER↓**	**BLEU↑**	**NIST↑**	**WER↓**	**PER↓**	**BLEU↑**	**NIST↑**	**WER↓**	**PER↓**
Sclera												
WAI-NOT	00.00	1.43	96.27	92.13	00.00	1.38	99.00	95.58	00.00	1.84	97.51	94.20
Lemmatis.	01.87*	1.68**	94.48	89.36	01.91*	1.73**	93.92	88.81	02.44*	2.29**	92.27	87.02
Direct	10.74**	2.93**	75.41	69.20	11.57**	3.05**	74.59	68.09	14.17**	3.68**	71.96	65.88
Synonyms	12.02*	3.32**	70.58	63.26	13.24*	3.41**	70.03	62.43	16.55**	*3.97***	*67.54*	*60.50*
Relations	11.44	3.29	72.24	64.50	12.75	3.42	71.41	63.26	16.12	3.96	68.78	61.33
Beta												
WAI-NOT	05.93	2.29	80.76	72.21	04.94	2.40	81.10	71.99	04.70	2.81	79.19	69.85
Lemmatis.	07.77	2.90**	77.05	66.93	08.15	3.01**	76.94	66.14	10.14**	3.53**	74.92	63.78
Direct	11.96**	3.65**	66.59	57.48	12.72**	3.76**	66.14	56.47	16.98**	4.43**	63.44	53.77
Synonyms	16.57**	4.12**	56.24	46.91	18.70**	4.28**	55.12	46.01	23.01**	5.00**	52.42	43.31
Relations	18.56*	4.22**	56.47	47.24	20.11*	4.40**	55.46	46.01	25.91**	5.17**	51.29	42.07

*$p < 0.05$,** $p < 0.01$.

Table 3.2: Automated evaluation of Text-to-Pictograph translation with one reference translation for the different experimental conditions.

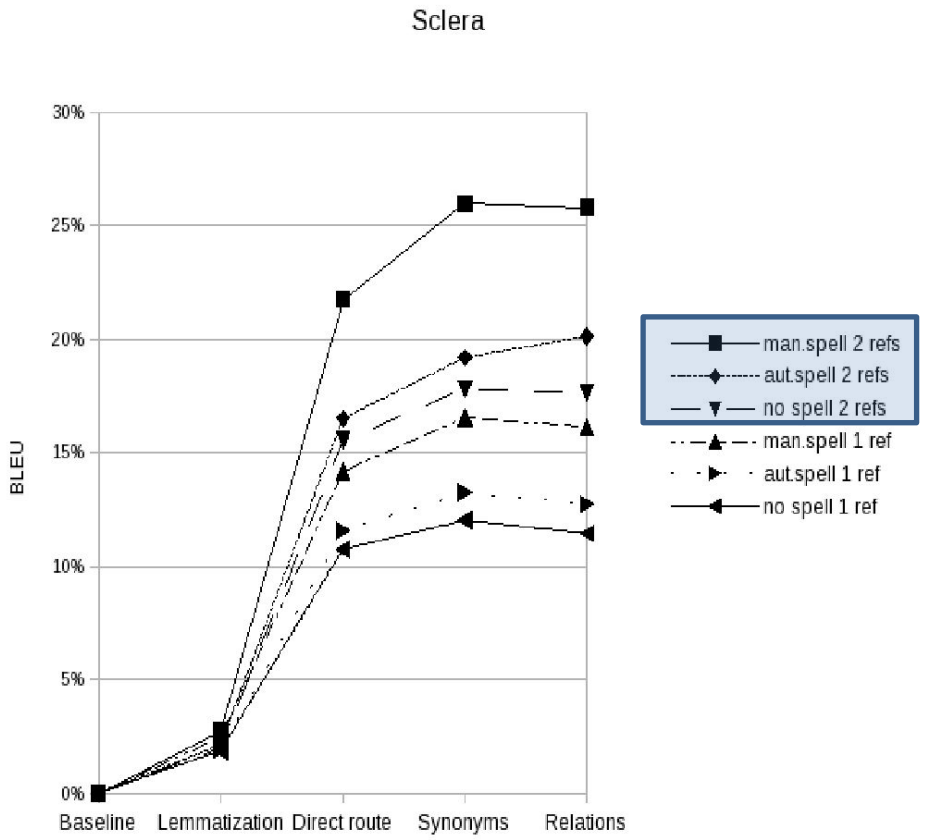
Adding relations did not help, apart from BLEU for Beta

Large gap between Beta and Sclera results

Large gap between Sclera and Beta

- Sclera consists of many more pictos than Beta
  - More difficult to manually translate text into Sclera (**quality of reference**)
  - Different paraphrasing is possible, resulting in less accurate quality metrics (**uniqueness of reference**)
- Solution: Creation of a second reference translation based upon post-editing system output

Results 2nd reference



Adding a post-editing reference closes the gap

Manual evaluation

- One judge
  - Remove untranslated non-content words to allow calculating recall
  - Judge for every translated word whether the pictograph is correct, to calculate precision
- Confirms similar quality for Beta and Sclera

Manual evaluation results

		Without proper names		With proper names	
Condition	**Precision**	**Recall**	**F-score**	**Recall**	**F-score**
Sclera					
WAI-NOT	77.60%	41.42%	54.01%	36.39%	49.55%
Text-to-Picto	89.24%	86.23%	87.71%	85.18%	87.16%
Rel. improv.	*15.00%*	*108.19%*	*62.39%*	*134.06%*	*75.92%*
Beta					
WAI-NOT	82.73%	62.23%	71.03%	59.57%	69.27%
Text-to-Picto	85.91%	89.45%	87.64%	88.68%	87.27%
Rel.improv.	*3.84%*	*43.73%*	*23.38%*	*48.88%*	*26.00%*

Table 3.3: Manual evaluation of the Text-to-Pictograph translation engine.

Version 2.0

Leen Sevens, Vincent Vandeghinste, Ineke Schuurman and Frank Van Eynde (2015). Extending a Dutch Text-to-Pictograph Converter to English and Spanish. In: *Proceedings of 6th Workshop on Speech and Language Processing for Assistive Technologies (SLPAT 2015)*. Dresden, Germany.

Extension to new languages:

- Make version 1.0 language independent
- Add language specific SLA tools, such as
  - PoS-taggers
  - Lemmatizers
- Treat language specific phenomena:
  - separable verbs in Dutch
  - prodrop in Spanish
- Transfer links between pictos and synsets to the WordNets of the added language

Transferring the links from Cornetto to Princeton

Cornetto

lemma	synset	relation
verdrietig	13989051	synonym

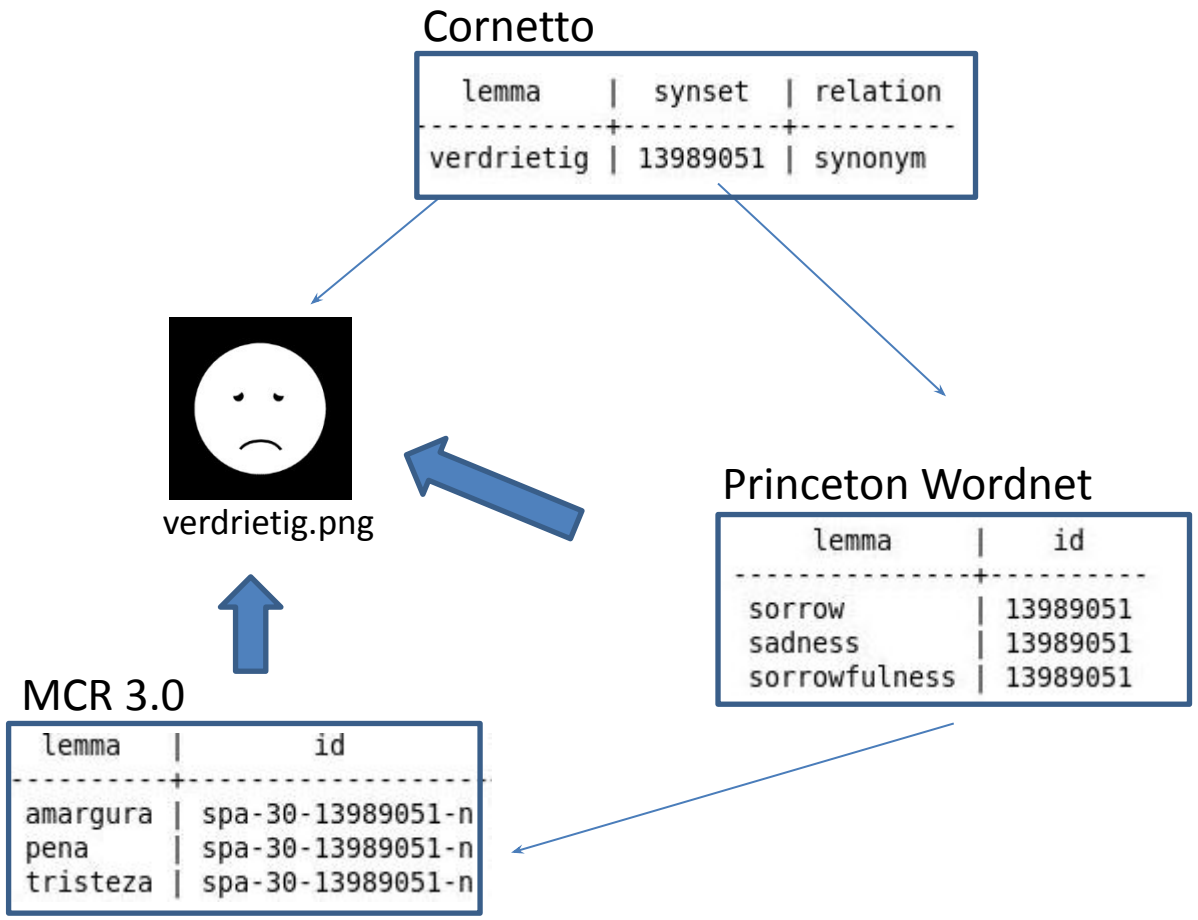
verdrietig.png

Princeton Wordnet

lemma	id
sorrow	13989051
sadness	13989051
sorrowfulness	13989051

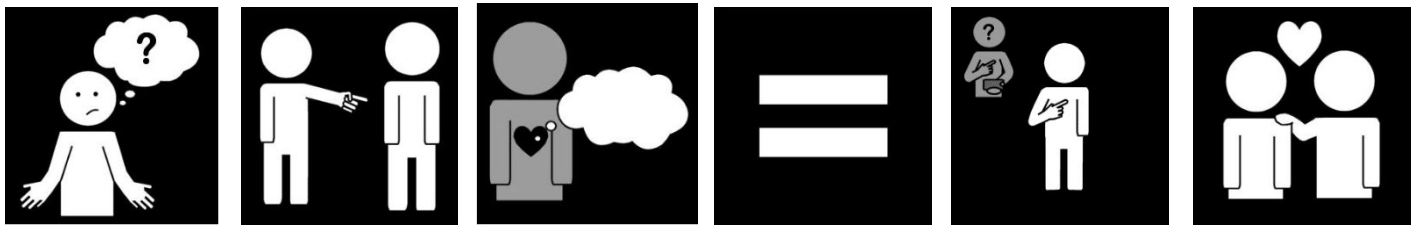
Leen Sevens, Vincent Vandeghinste & Frank Van Eynde (2014). Improving the Precision of Synset Links Between Cornetto and Princeton WordNet. CoLing 2014 *Workshop on Lexical and Grammatical Resources for Language Processing (LG-LP 2014)*. pp. 120-126.

Transferring the links from Cornetto to MCR 3.0 (Spanish)

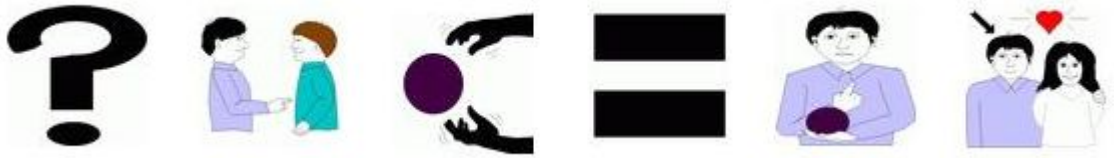


Further adaptations

- Specific linguistic resources (POS taggers, lemmatizers, first names databases)
- Manual corrections based on emails sent by the users



Sclera



Beta

Dealing with **language-specific properties**

Fix the Spanish “pro-drop” problem: display pronouns that are “hidden” in the verb

- Otherwise, the pictograph sequence would not contain any information on the subject of the verb at all
- Rule-based solution
  - Ex. “Quiero agua” (want-1sg water) -> “Yo quiero agua” (I want water)

English to picto manual evaluation

Condition	Precision	With proper names Recall	With proper names F-Score	Without proper names Recall	Without proper names F-Score
Sclera					
Baseline	71.37%	61.25%	65.92%	62.25%	66.50%
Add frequent concepts	93.30%	71.95%	81.25%	73.04%	81.94%
Rel. improv.	*30.73%*	*17.47%*	*23.26%*	*17.33%*	*23.22%*
Beta					
Baseline	75.08%	70.63%	72.78%	71.71%	73.36%
Add frequent concepts	82.56%	85.07%	83.80%	86.14%	84.31%
Rel.improv.	*9.96%*	*20.45%*	*15.14%*	*20.12%*	*14.93%*

added or edited the 500 most frequently used words according to the (automatically translated) Dutch WAI-NOT corpus

Spanish to picto manual evaluation

Condition	Precision	With proper names Recall	With proper names F-Score	Without proper names Recall	Without proper names F-Score
Sclera					
Baseline	73.84%	57.63%	64.74%	58.30%	65.16%
Add frequent concepts	93.31%	82.17%	87.38%	83.14%	87.93%
Rel. improv.	*26.37%*	*42.58%*	*34.97%*	*42.61%*	*34.95%*
Beta					
Baseline	83.48%	60.83%	70.38%	61.26%	70.66%
Add frequent concepts	94.64%	86.01%	90.12%	86.83%	90.57%
Rel.improv.	*13.37%*	*41.39%*	*28.05%*	*41.74%*	*28.18%*

Conclusions for v2.0

- We have created reasonably functioning Text2Picto systems for three source languages and two target languages
- There is a clear approach on how to add new languages

User Testing

- Social media text: too many spelling mistakes
- Wrong translations → Word Sense Disambiguation
- Sentences are too long: unreadable as picto sequences

Version 3.0

- Improved spelling correction
- Proper word sense disambiguation
- Sentence simplification

Leen Sevens (2018). "Words Divide, Pictographs Unite: Pictograph Communication Technologies for People with an Intellectual Disability." PhD thesis. LOT.

Spelling

- **Leen Sevens, Tom Vanallemeersch, Ineke Schuurman, Vincent Vandeghinste and Frank Van Eynde** (2016). "Automated Spelling Correction for Dutch Internet Users with Intellectual Disabilities". In: *Proceedings of 1st Workshop on Improving Social Inclusion using NLP: Tools and Resources (ISI-NLP, LREC workshop).* Portorož, Slovenia, pp. 11-19.
- **Problem:** some users write short messages without using Picto-to-Text
  - Good: encourage them to write their own messages!
  - Bad: severe spelling errors!
- **Consequences:**
  - If the receiver can read (to some extent): many errors make the message difficult to read
  - If the receiver uses Text-to-Picto to read: the tool may retrieve erroneous pictographs or no pictographs at all

Evaluation

- **Intrinsic evaluation**
  - Another 300 manually corrected WAI-NOT messages
  - **Baseline:** the original set of uncorrected messages
  - **Also shown:** the original spelling correction tool that we developed for Text-to-Picto (context-insensitive 1-character substitution/insertion/deletion)

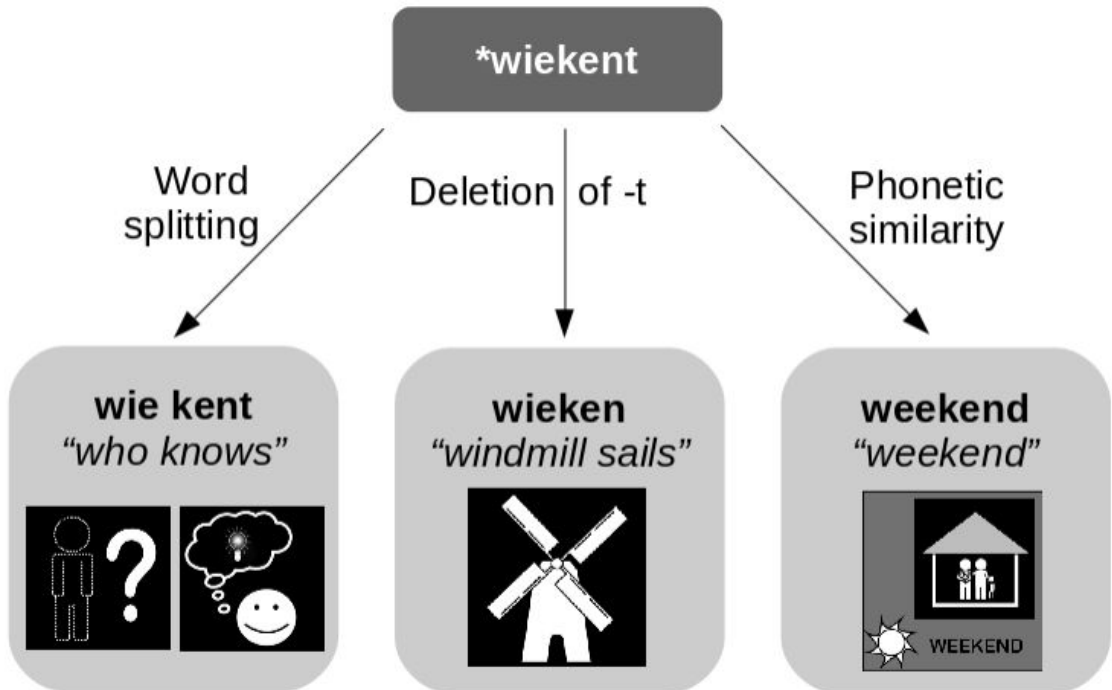
System used	BLEU↑	NIST↑	WER↓	# Character operations
No corrector	64.02	8.62	12.37	699
Old corrector	62.88**	8.07**	19.51	816
New corrector (language model)	78.72**	10.23**	8.02	298
New corrector (fuzzy match)	**84.04****	**10.49****	7.57	238

Table 4.8: Automated evaluations on 300 email messages. $*p < 0.05, **p < 0.01$.

- **Extrinsic evaluation**
  - Within the larger context of the Text-to-Picto tool
  - 50 Dutch messages that have been sent with the WAI-NOT email system (84 sentences), translated into a sequence of Sclera or Beta pictographs using the Text-to-Picto translation tool
  - Precision and recall (manual annotation by one judge)

		With proper names		Without proper names	
Condition	**Precision**	**Recall**	**F-Score**	**Recall**	**F-Score**
Sclera					
Baseline	89.2%	86.2%	87.7%	85.2%	87.2%
New system	92.6%	89.1%	90.8%	88.2%	90.3%
Rel.improv.	*3.7%*	*3.3%*	*3.5%*	*3.6%*	*3.6%*
Beta					
Baseline	85.9%	89.5%	87.6%	88.7%	87.3%
New system	89.8%	91.5%	90.6%	90.8%	90.3%
Rel. improv.	*4.5%*	*2.3%*	*3.4%*	*2.4%*	*3.5%*

Table 7: Manual evaluation of the Text2Picto translation engine


*wiekent
Word splitting
Deletion of -t
Phonetic similarity
wie kent
“who knows”
wieken
“windmill sails”
weekend
“weekend”
WEEKEND

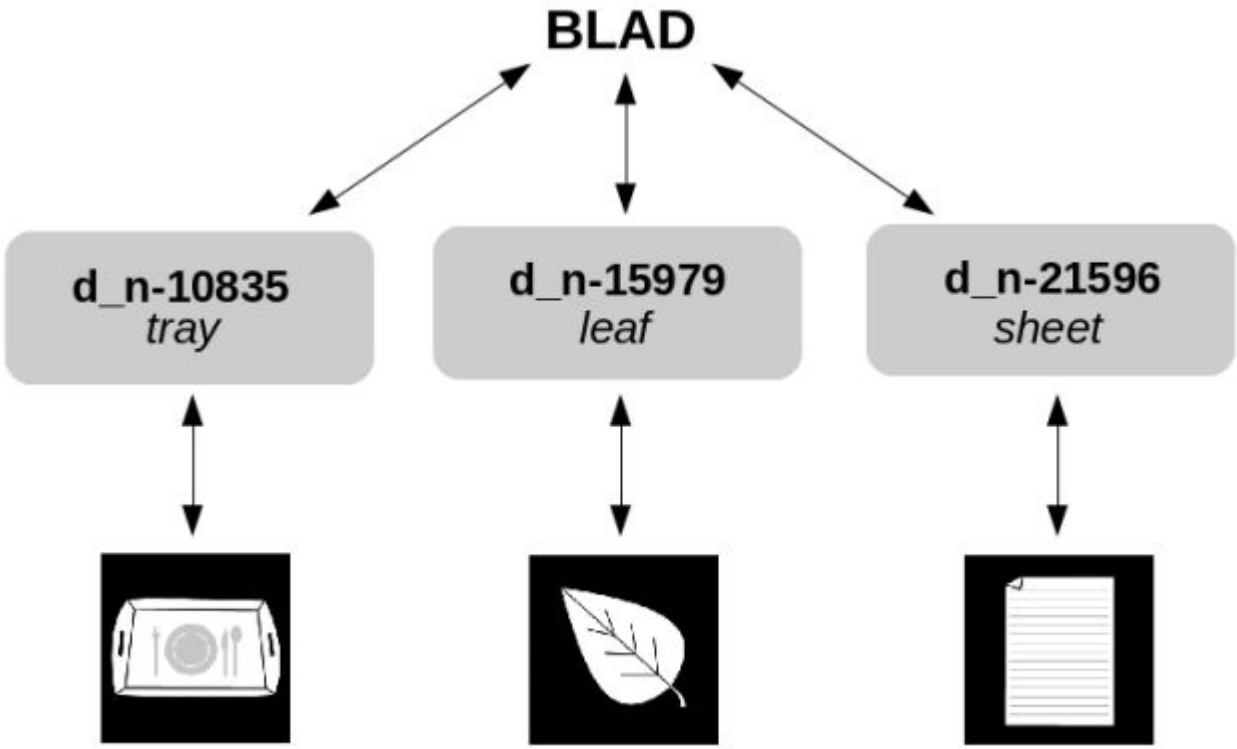
Word Sense Disambiguation

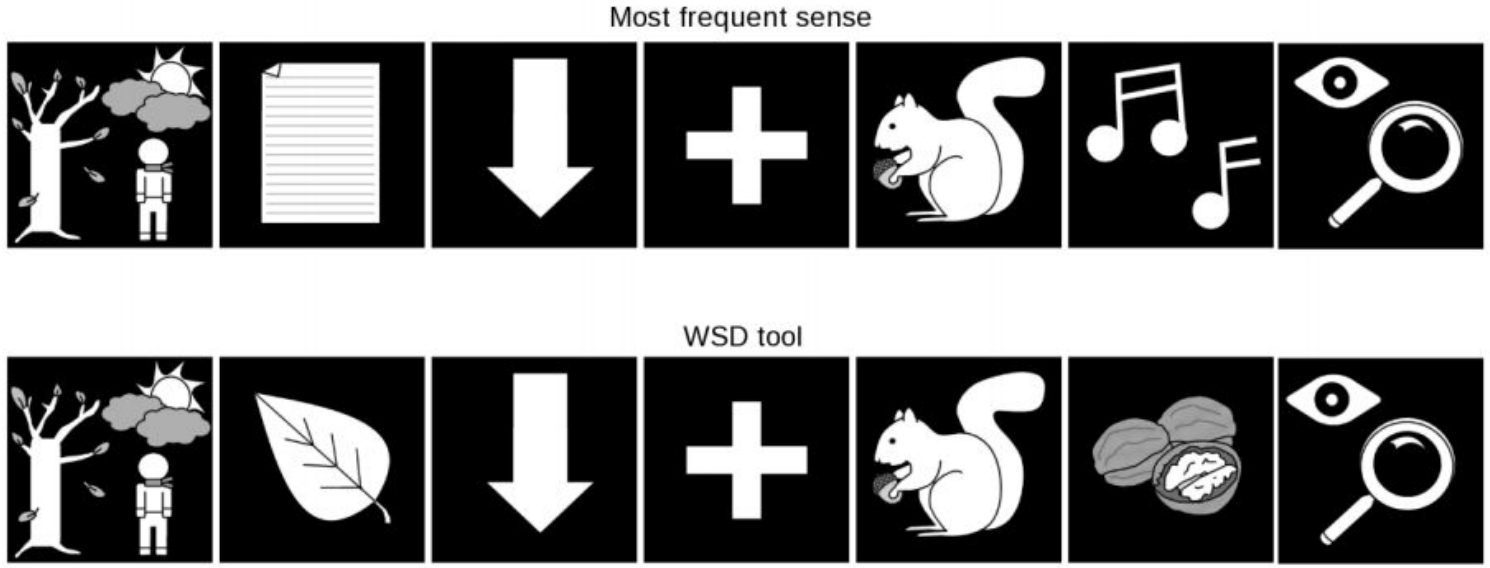
Leen Sevens, Gilles Jacobs, Vincent Vandeghinste, Ineke Schuurman and Frank Van Eynde (2016). Improving Text-to-Pictograph Translation Through Word Sense Disambiguation. In: *Proceedings of the 5th Joint Conference on Lexical and Computational Semantics*. Berlin, Germany.

Making use of DutchSemCor

Piek Vossen, Attila Görög, Ruben Izquierdo, and Antal Van den Bosch (2010). DutchSemCor: Targeting the ideal sense-tagged corpus. In: *Proceedings of the 8th International Conference on Language Resources and Evaluation* (LREC), Istanbul, Turkey.

Word Sense Disambiguation: find the right meaning of a word





“(dat) in de winter de <u>blaadjes</u> vallen en de eekhoorn <u>nootjes</u> zoekt.”

(that) in winter the leaves fall and the squirrel nuts searches

Simplification

Leen Sevens, Vincent Vandeghinste, Ineke Schuurman and Frank Van Eynde (2017). "Simplified Text-to-Pictograph Translation for People with Intellectual Disabilities". In: *Proceedings of the 22nd International Conference on Natural Language & Information Systems (NLDB 2017)*. Liège, Belgium

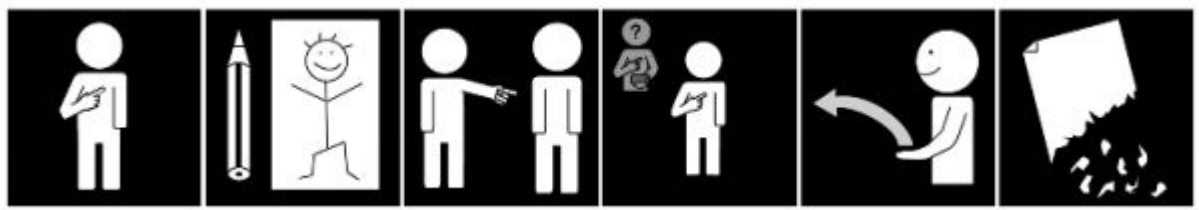
Problem Definition

Long input sentences

Volgend jaar in september willen we samen basket doen in de sporthal van de school.
Next year in September want we together basket do in the sports-hall of the school.
'Next year in September we want to play basket together in the sports hall of the school.'

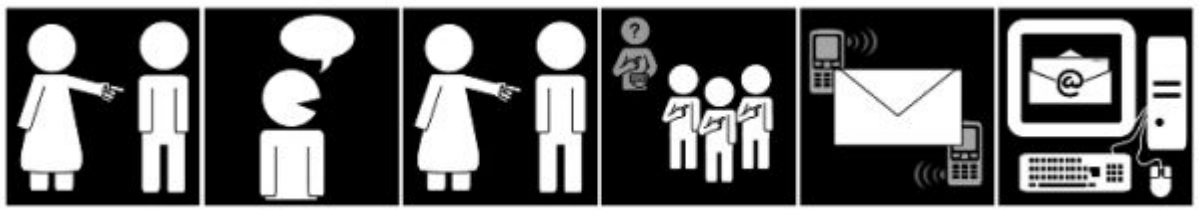
Coordinated and complex sentences

Ik heb de tekening die jij aan mij gegeven hebt verscheurd.
I have the drawing that you to me given have torn-up.
'I have torn up the drawing that you gave me.'



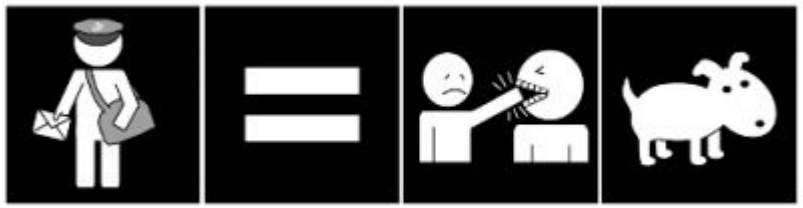
Non-SVO order

Hij zegt dat hij ons een berichtje gemaild heeft.
He says that he us a message mailed has.
'He says that he has mailed us a message.'



Passive sentences

De postbode wordt gebeten door de hond.
The mailman is bitten by the dog.
'The mailman is bitten by the dog.'



Solution:

Apply syntactic simplification as a pre-processing step for Text-to-Pictograph translation

Objectives

ID	Phenomenon	Operations
(a)	Coordinated sentence	- Split into two or multiple sentences - Identify the antecedent (subject) if subject is covert (in case of ellipsis)
(b)	Subordinate clause	- Detach from the main clause
(c)	Clause order	- Determine the subordinate clause's temporal or logical position with respect to the main clause
(d)	Participial phrase	- Detach from the main clause - Identify the antecedent (subject)
(e)	*(om) te "to"* + infinitive clause	- Detach from the main clause - Identify the antecedent (subject)
(f)	Relative clause	- Detach from the main clause - Identify the antecedent (subject, direct object, or indirect object)
(g)	Embedded appositive clause	- Place the verb *to be* in front of the apposition - Identify the antecedent (subject)
(h)	Adverbial phrase or prepositional phrase in theme position	- Move to the back of the sequence
(i)	Covert subjects or objects in the newly created independent clause	- Place all the antecedents at their appropriate positions within the clause
(j)	Non subject-verb-object order	- Convert to subject-verb-object order - Cluster all the verbs at the verb position
(k)	Passive voice	- Place the agent at the patient's position and vice versa
(l)	*Extra: Compression*	*- Delete pictographs that do not contribute to the essence of the message*

Ik ben woensdag een lieve baby gaan bezoeken en ik heb hem een papfles gegeven.
I am Wednesday a cute baby go visit and I have him a bottle given.
'On Wednesday I went to visit a cute baby and I gave him the bottle.'

Old

New (with compression)

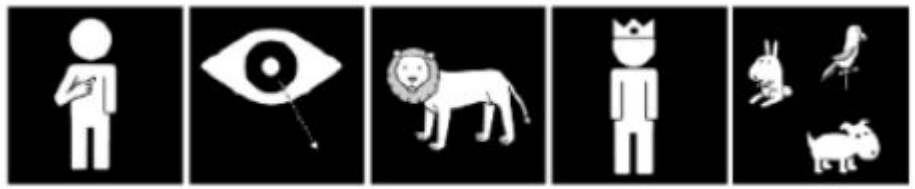
De vogel die jij hoort is een pauw.
The bird that you hear is a peacock.

'The bird that you're hearing is a peacock.'

Old

New

Ik zag een leeuw, de koning van de dieren.
I saw a lion, the king of the animals.
'I saw a lion, the king of the animals'



Old

New

System Description

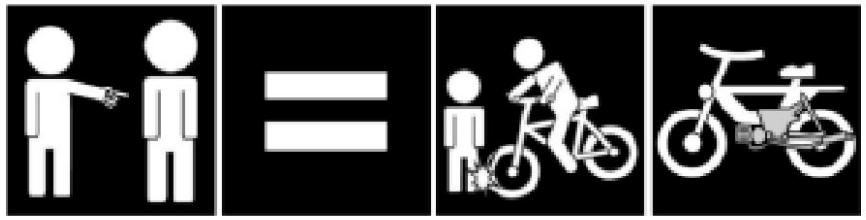
1. Parse with Alpino *(van Noord, 2011)*
2. Mark clause type, indicate interrogation and passivity, identify the antecedents
3. Insert the antecedents and re-order the syntactic constituents
    - Detopicalise prepositional phrases and adverbs
    - Create a verb cluster
    - Create SVO-type clauses (insert antecedent at its S or O position, move verb cluster to V position)
    - Appositive clauses: add a *to be*
    - “Passive” feature: switch agent and patient, remove *worden “to be”*

Manual Evaluation

- Collaborate with the target users' environment
  - Family members, teachers, etc. play an important role in the communication process with the target users.
  - Participants must concentrate for a prolonged period of time, to answer 47 questions
  - Meta-questions concerning the difficulty of the pictograph translations

Manual Evaluation: Example

Non-simplified



Je werd aangereden door een motor. 'You were hit by a motorcycle.'

Simplified

Ik word gepest door een meisje. 'I am being bullied by a girl.'

- Difficulty: 1 = too difficult, 10 = easy enough
- Translate into Dutch -- manually check whether translations are correct

Manual Evaluation: Results

	Z-value	p-value level
Passivity	-0.0933	-
Relative clause	-4	**
Subordination	-3.1492	**
Coordination	-0.4829	-
Appositive clause	-1.0601	-
Subordination + passivity	-2.8857	**

Table 5.10: Results of the Wilcoxon signed-rank test. $*p < 0.05, **p < 0.01$.

+ qualitative results

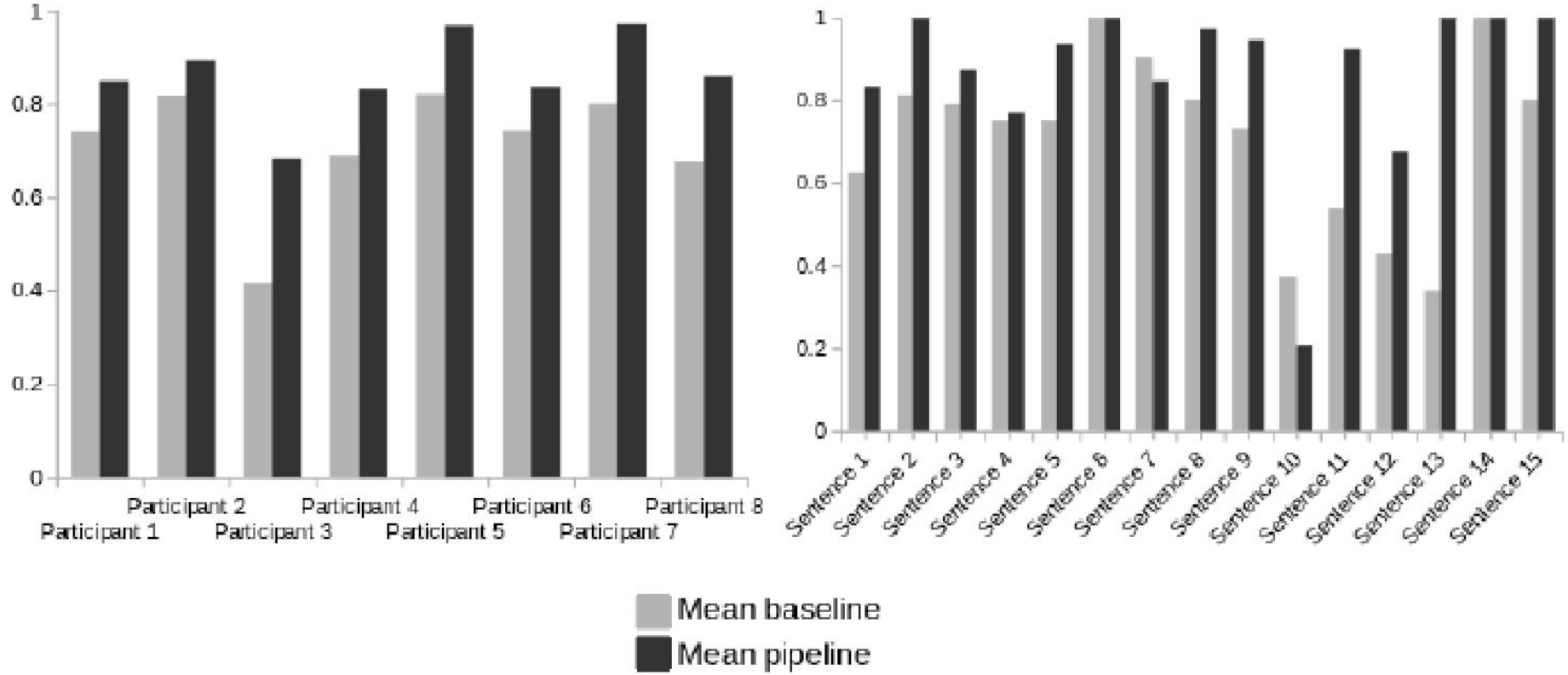
Conclusions about Simplification

- **First step toward the creation of a simplification tool for Dutch**
  - I.e., for generating textual output, not pictograph output
  - Requires additional grammar checker
  - Requires additional lexical simplification
- **Fast: only one syntactic parse (Alpino) needed per sentence**
  - Using recursion and loops
  - Applying the simplification rules in a logical way

Evaluating the Text-to-Picto Pipeline

- Human evaluation: user survey
  - Objective evaluation: accuracy of transcriptions, overlap in content words (or synonyms)
  - Subjective evaluation: estimate quality of transcriptions
  - 15 input sentences:
    - baseline pictograph translation
    - pipeline pictograph translation
  - OOV Words: black pictograph

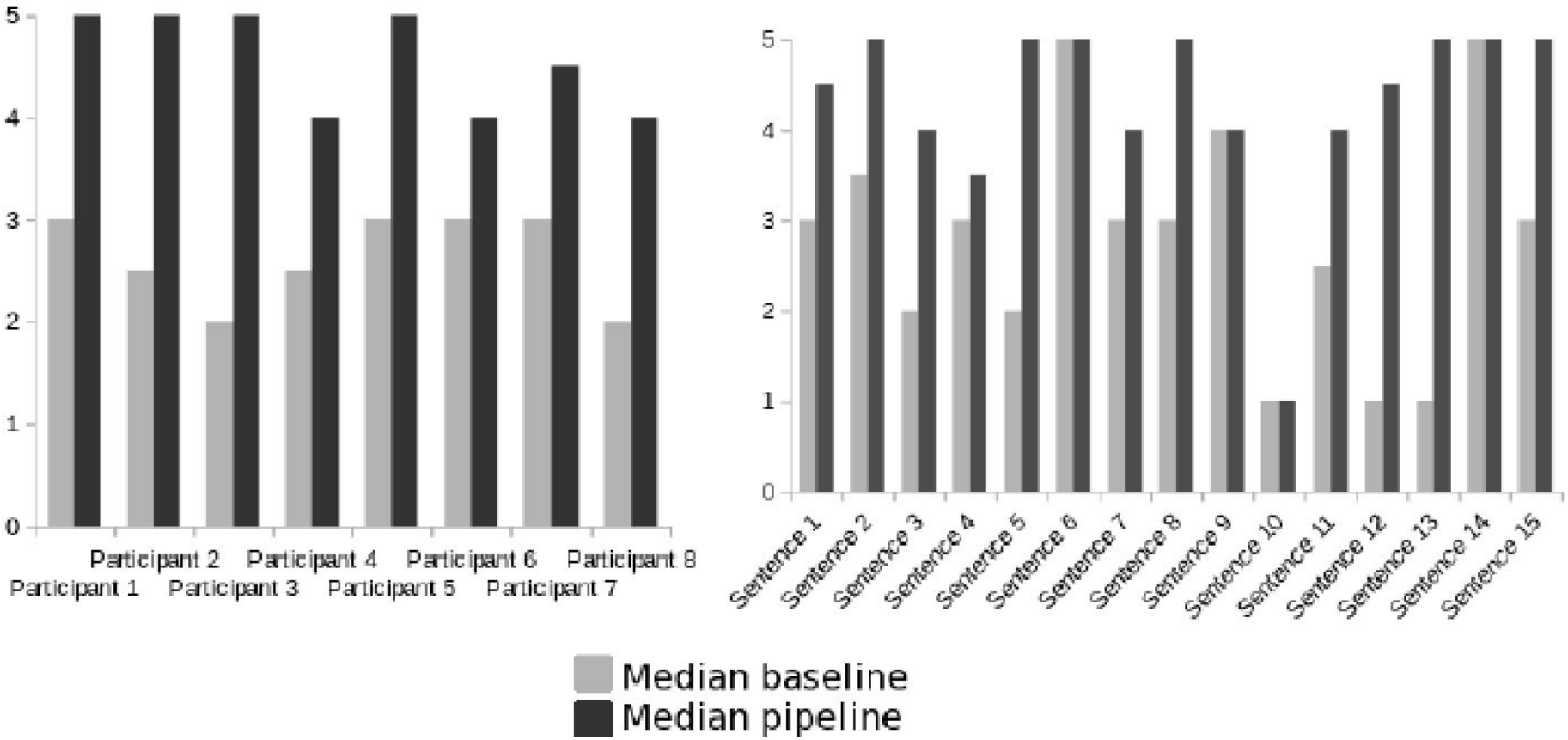
Objective Human Evaluation



Subjective Human Evaluation

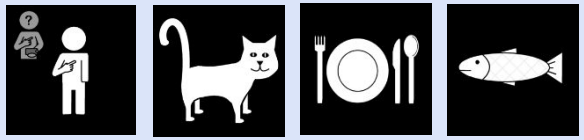
- One human judges overall quality of the transcriptions
- Blind
- 5-point scale
    - 5: all meaning is preserved,
    - 1: no meaning is preserved

Subjective Human Evaluation



PICTOGRAPH-TO-TEXT CONVERSION

Sequence of pictographs



Sclera

Beta

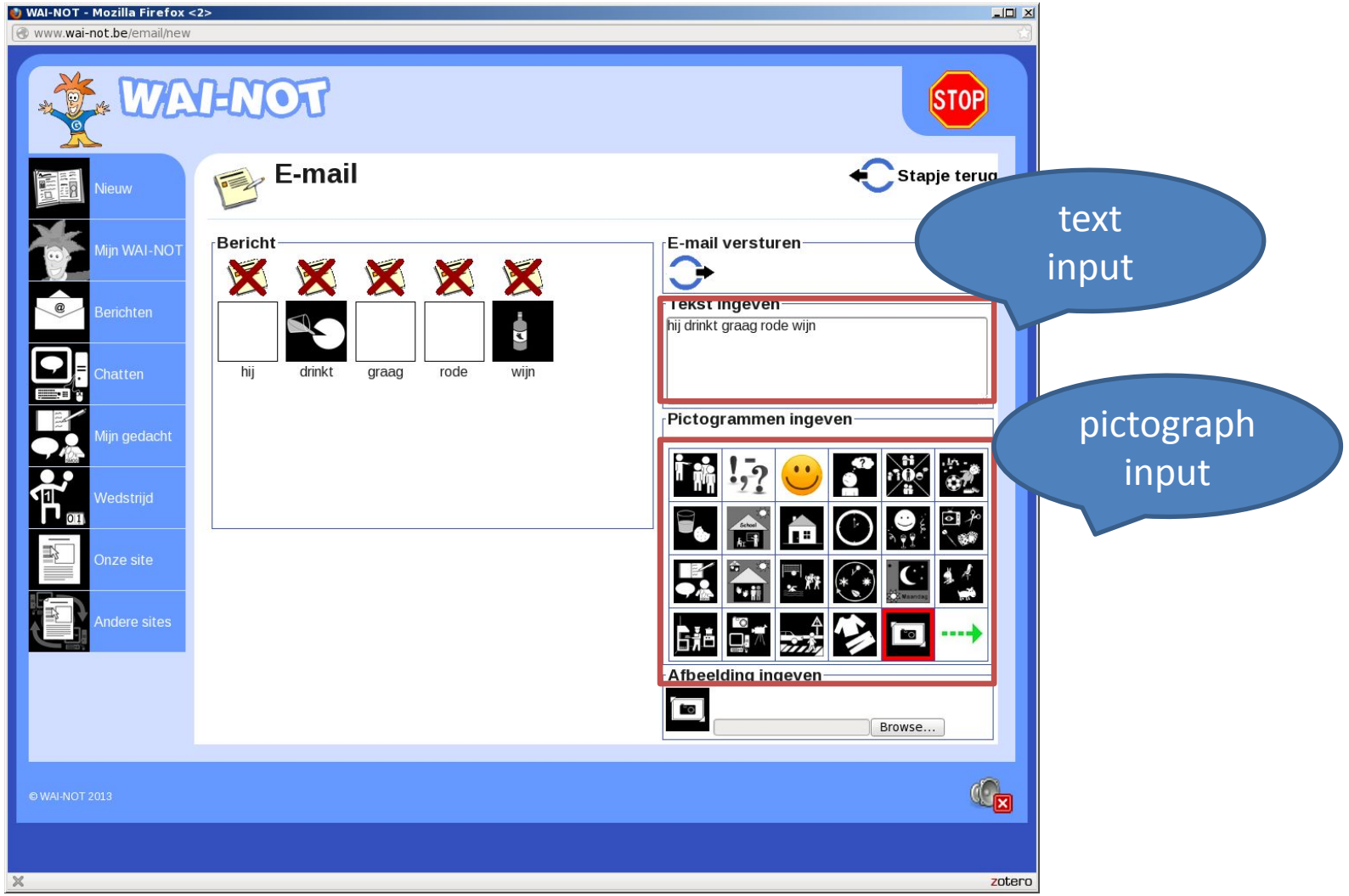
Text

Mijn kat eet een vis.
My cat eats a fish.
Mi gato come un pez.

The Old WAI-NOT Interface

- **Not developed in collaboration with the users**
- **Two-level** category system
  - 21 Beta categories and 39 Sclera categories
  - An average of 118 Beta pictographs and 73 Sclera pictographs per category
- Pictographs would **change positions** depending on frequency of use
  - Closely related pictographs were not shown together
  - Discourages users to familiarise themselves with the positions
- Pictographs were **not** distributed in a **consistent** way
  - Female teacher: in *school* category, not in *professions* or *people*
  - Male teacher: in *professions* category, not in *school* or *people*
- **Less discussed topics** were shown at the top level, ex. *religion*, *housekeeping*

Input methods: old approach



Input methods: new approach

- **Leen Sevens, Jo Daems, Annelies De Vliegher, Ineke Schuurman, Vincent Vandeghinste and Frank Van Eynde** (2017). "Building an Accessible Pictograph Interface for Users with Intellectual Disabilities" In: *Proceedings of the 2017 AAATE Congress*. Sheffield, UK.

The New Interface

- **Three-level** category system
  - 12 top-level categories, with 3 to 12 subcategories each
  - An average of 21 Beta pictographs and 28 Sclera pictographs per subcategory
- What are the **top-level categories?**
  - Latent Dirichlet Allocation (LDA) analysis: hidden topics in WAI-NOT email corpus
  - Clusters words that frequently occur together
  - Ex. One frequent topic: *fries, hamburger, waffle, pizza, croissant, drink, delicious, salt*

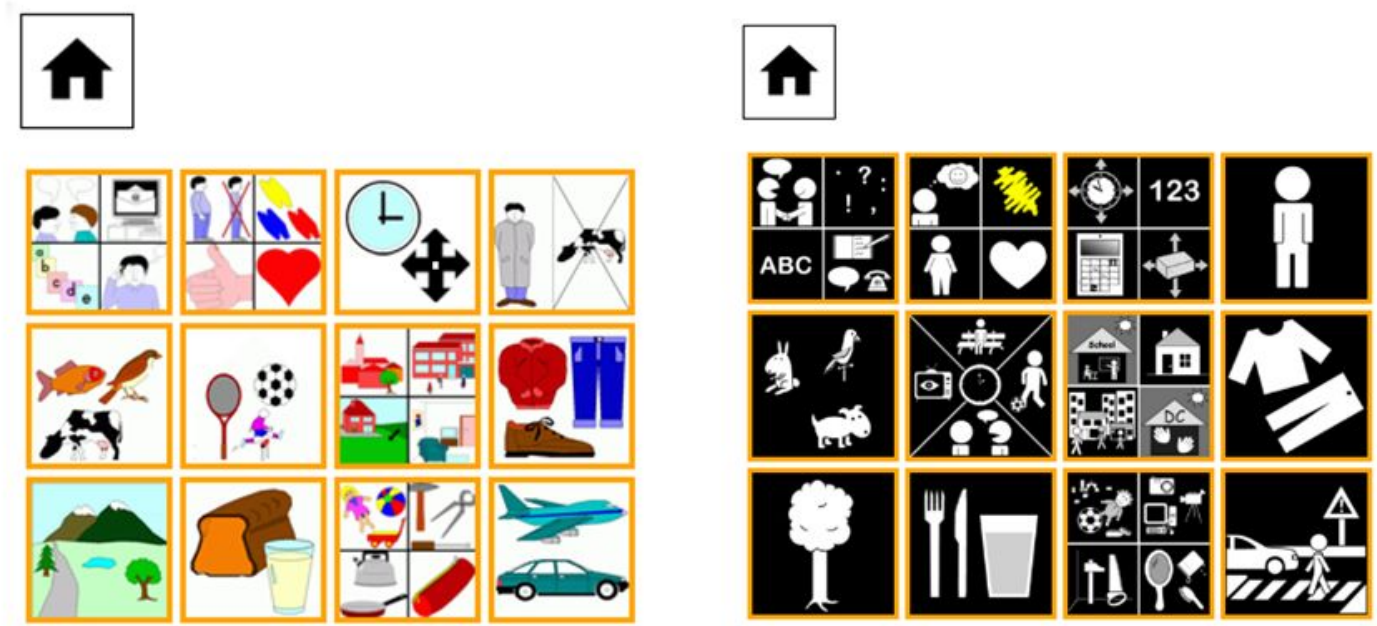


Figure 1. The top-level (*Home*) categories in the Beta interface (left) and the Sclera interface (right). The top-level pictographs were assigned an orange border, indicating that a user may click on them in order to access the subcategories.

- What are the **subcategories?**
  - We used Cornetto: a WordNet (a word database with meaning relations)
  - For instance: *animal* is a supercategory for *bird*, *farm animals*, *insects*,…
- What is the **third level**?
  - Pictographs for the user to choose from
  - Assigned manually
  - Ordered by frequency in the WAI-NOT email corpus (fixed positions!)
  - Exceptions: closely related concepts
  - Some pictographs appear in different subcategories
- Try it: http://picto.ccl.kuleuven.be/ScleraInterface.php#

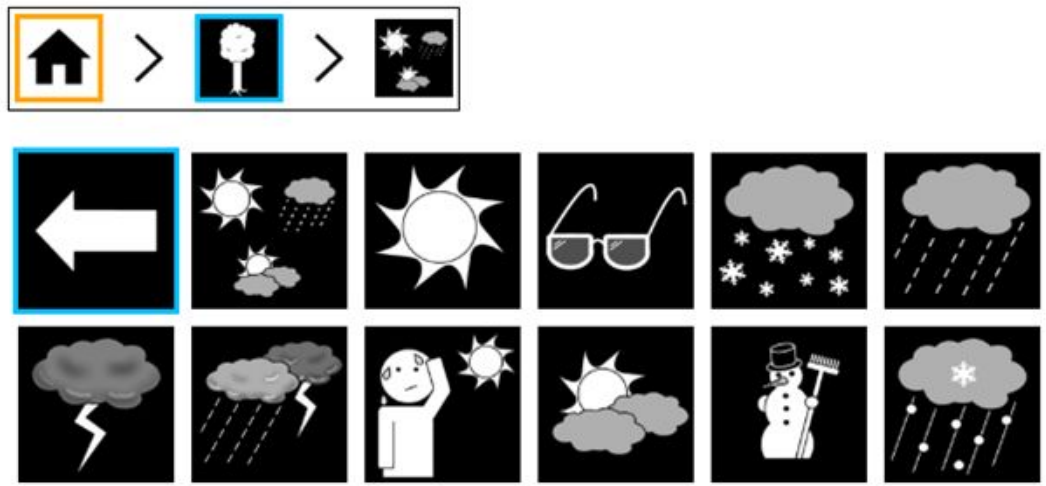


Figure 2. *Home* > *Nature* > *Weather* in the new Sclera interface. This bottom-level category contains all pictographs related to weather. Clicking the orange-bordered *home* pictograph brings the user back to the top level (*Home*), while the blue-bordered pictographs link back to the second level in the hierarchy (*Nature*).

Evaluations Based on WAI-NOT Data

- **Comparison:** 1000 random old messages & 1000 random new messages sent on WAI-NOT
  - More people write pictograph messages: 16,6% (old) versus 25% (new)
  - More pictograph messages with very clear communicative content: 30% (old) versus 68% (new)
  - More exploration of other subcategories: 43% (old) versus 74% (new)

Evaluations with users

- **Testing the new interface**
  - Intuitive use of “back” arrow and category browsing
  - Suggestion: “enlarge pictographs”
  - Finding a pictograph of their choice: easy!
  - Familiarisation and training can also have positive effects
  - A will to learn how to work with all categories
  - A desire to use Picto2Text on social media

Conclusion about new interface

- The **first** pictograph-based reading & writing tools that can be used in combination with existing social media apps and email
- Interface: **improvement** over the old system
  - One adjustment: personalisation (disabling (sub)categories)
  - Enlarge pictographs should be made possible
  - Options for use of switch or joystick are being considered
  - Pictograph prediction
- **User-centered design:** specifying the context of use and the user requirements = valuable for the design of technical solutions

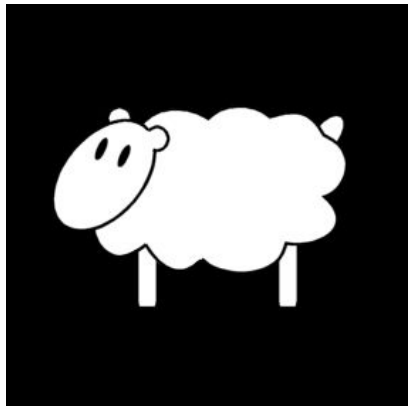
PICTO TO NATURAL LANGUAGE GENERATION

The challenge…

A pictograph can correspond to different (synonymous) lemmas

cash, geld, poen, cent, euro,…

Most pictographs make no distinction between singular and plural



schaap, schaapje, schapen, schaapjes, …

Verbs are not inflected, and there are no temporal auxiliaries

dans, dansen, danste, dansten, dansend, …

There are (almost) no function words (determiners, prepositions,…)

Nothing to show here

Picto2text 2.0

- **Approach #1: Language Models**
  - #1: *N*-gram-based approach
  - #2: Long Short-Term Memory-based approach (Neural Networks)
- **Approach #2: Machine Translation**
  - #1: Phrase-based Machine Translation (Moses)
  - #2: Neural Machine Translation (OpenNMT)

- **Parallel Corpus #1: Text2Picto corpus**
  - **Target:** “Subtitles” component of SoNaR (Oostijk et al. 2013) (27.6M tokens)
    - “Daily life” vocabulary (emotions, objects, etc.)
    - Includes 1st and 2nd person forms
    - Correctly written text
  - **Source:** Translate the “Subtitles” component into Beta and Sclera pictographs using Text2Picto
    - Note: possible error propagation

- **Parallel Corpus #2: Demolished corpus (synthetic data)**
  - **Target:** “Subtitles” component of SoNaR (Oostijk et al. 2013)
  - **Source:** Demolish the “Subtitles” component
    - Lemmatise the corpus
    - Remove all function words and auxiliaries
    - > Make it look like pictograph input (when you replace it by its most frequent lemma)
    - Also make a factored parallel corpus which includes POS information

Condition	BLEU↑	NIST↑	WER↓	PER↓	MET.↑	TER↓
Sclera						
5-gram mixed-dom. corpus	05.44	3.00	63.28	58.62	33.60	65.95
5-gram CGN corpus	06.30	2.67	63.96	60.27	32.99	66.46
5-gram SoNaR subt. corpus	**08.26**	**3.01**	**62.40**	**57.66**	**35.21**	**65.03**
LSTM mixed-dom. corpus BRNN 750	03.52	2.47	78.78	70.83	22.02	81.74
LSTM CGN corpus BRNN 750	04.05	2.85	73.55	65.50	26.34	75.69
LSTM SoNaR subt. corpus BRNN 750	03.75	2.04	87.80	81.98	18.13	88.51
Beta						
5-gram mixed-dom. corpus	07.59	3.24	62.69	58.72	41.72	82.60
5-gram CGN corpus	09.42	**3.45**	**60.17**	**55.52**	**39.34**	**60.72**
5-gram SoNaR subt. corpus	**09.73**	3.43	61.14	56.78	38.46	62.26
LSTM mixed-dom. corpus BRNN	06.92	3.06	70.35	64.63	31.44	71.49
LSTM CGN corpus BRNN 750	07.47	3.34	65.89	59.69	33.45	67.38
LSTM SoNaR subt. corpus BRNN 750	07.14	3.31	67.25	61.05	33.13	68.41

Condition	BLEU↑	NIST↑	WER↓	PER↓	MET.↑	TER↓
Sclera						
Moses Deconstructed corpus non-fac.	06.27	3.06	76.65	64.53	27.21	75.49
Moses Deconstructed corpus fac.	05.86	**3.16**	73.06	62.31	27.92	72.31
Moses Text2Picto corpus non-fac.	05.58	2.75	67.83	59.88	30.42	68.62
Moses Text2Picto fac.	07.31	2.92	**63.37**	**57.27**	**33.71**	**65.44**
OpenNMT Deconstructed corpus 500	07.52	2.86	78.20	67.25	25.87	76.31
OpenNMT Text2Picto corpus 500	07.88	2.61	76.84	67.64	28.18	69.74
OpenNMT Text2Picto corpus BRNN 500	08.51	2.84	75.10	65.02	29.55	68.41
OpenNMT Text2Picto corpus BRNN 750	**11.14**	2.90	75.29	66.18	30.87	68.00
Beta						
Moses Deconstructed corpus non-fac.	07.25	3.46	71.51	60.37	30.29	71.28
Moses Deconstructed corpus fac.	07.34	**3.58**	68.41	56.49	31.98	68.10
Moses Text2Picto corpus non-fac.	08.30	3.28	65.41	54.07	31.25	64.51
Moses Text2Picto fac.	09.34	3.44	**63.76**	**52.81**	**32.32**	**63.59**
OpenNMT Deconstructed corpus 500	07.85	3.07	75.10	64.24	28.03	77.94
OpenNMT Text2Picto corpus 500	08.15	2.96	70.64	57.85	28.84	67.59
OpenNMT Text2Picto corpus BRNN 500	09.01	2.92	67.05	54.75	28.63	68.31
OpenNMT Text2Picto corpus BRNN 750	**12.93**	3.33	66.57	55.23	30.76	65.74

Machine translation: observations

- The machine translation approaches outperform the language model approaches
  - Change in order of pictographs possible
  - MT can generate function words
  - The output is more fluent
- OpenNMT: performs equally as good as / better than Moses
- The T2P corpus outperforms the demolished corpus

User Judgements

- Compare outputs of best systems wrt
  - Adequacy
  - Fluency
  - Pairwise Ranking

User Judgement

Condition	Adequacy (median)	Fluency (median)
Sclera		
5-gram SoNaR subt. corpus	4	3
LSTM CGN corpus BRNN 750	3.5	2.5
Moses Text2Picto fac.	5	4
OpenNMT Text2Picto corpus BRNN 750	5	4.5
Beta		
5-gram SoNaR subt. corpus	4	3
LSTM CGN corpus BRNN 750	3	2
Moses Text2Picto fac.	5	4
OpenNMT Text2Picto corpus BRNN 750	5	4

Recent work

Magali Norré (2025). *Automatic Translation from French into Pictographs to Improve Communication between Doctors and Patients with an Intellectual Disability in Hospitals.* PhD research at UCLouvain

Extended to French and to ARASAAC

Magali Norré, Vincent Vandeghinste, Pierrette Bouillon and Thomas François (2021). Extending a Text-to-Pictograph System to French and to Arasaac. *Proceedings of the International Conference Recent Advances in Natural Language Processing (RANLP).* pages 1050–1059, Held Online. INCOMA Ltd.

WOLF = WOrdnet Libre du Français or WOLF (Sagot and Fiser, 2008)

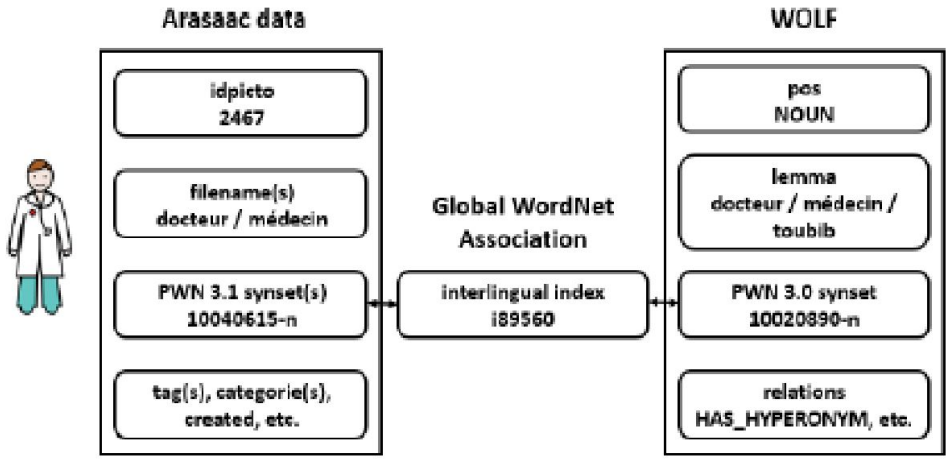


Figure 1: Mapping Arasaac pictographs with French WordNets.

	BLEU	WER	PER
Sclera			
Dictionary	12.0 (0.0)	58.7 (0.0)	55.8 (0.0)
(Sevens, 2018)	14.1	71.9	65.8
+ Synonyms	17.8 (0.4)	**56.2** (0.4)	**50.3** (0.4)
(Sevens, 2018)	16.5	67.5	60.5
+ Relations	**17.9** (0.4)	56.2 (0.3)	50.8 (0.3)
(Sevens, 2018)	16.1	68.7	61.3
Beta			
Dictionary	10.9 (0.0)	63.0 (0.0)	62.1 (0.0)
(Sevens, 2018)	16.9	63.4	53.7
+ Synonyms	21.6 (1.4)	**57.5** (1.1)	**52.1** (1.1)
(Sevens, 2018)	23.0	52.4	43.3
+ Relations	**22.4** (1.2)	57.9 (0.5)	52.6 (0.6)
(Sevens, 2018)	25.9	51.2	42.0
Arasaac			
Dictionary	7.3 (0.0)	**59.3** (0.0)	58.8 (0.0)
(Sevens, 2018)	–	–	–
+ Synonyms	24.8 (0.7)	68.1 (1.5)	57.6 (1.4)
(Sevens, 2018)	–	–	–
+ Relations	**24.9** (0.8)	68.0 (1.9)	**57.2** (1.7)
(Sevens, 2018)	–	–	–

Medical Coverage of a Translation System into Pictographs for Patients with an Intellectual Disability

Magali Norré, Vincent Vandeghinste, Thomas François and Pierrette Bouillon (2022). Investigating the Medical Coverage of a Translation System into Pictographs for Patients with an Intellectual Disability. *Proceedings of the 9th Workshop on Speech and Language Processing for Assistive Technologies (SLPAT).* pages 44–49, Dublin, Ireland.

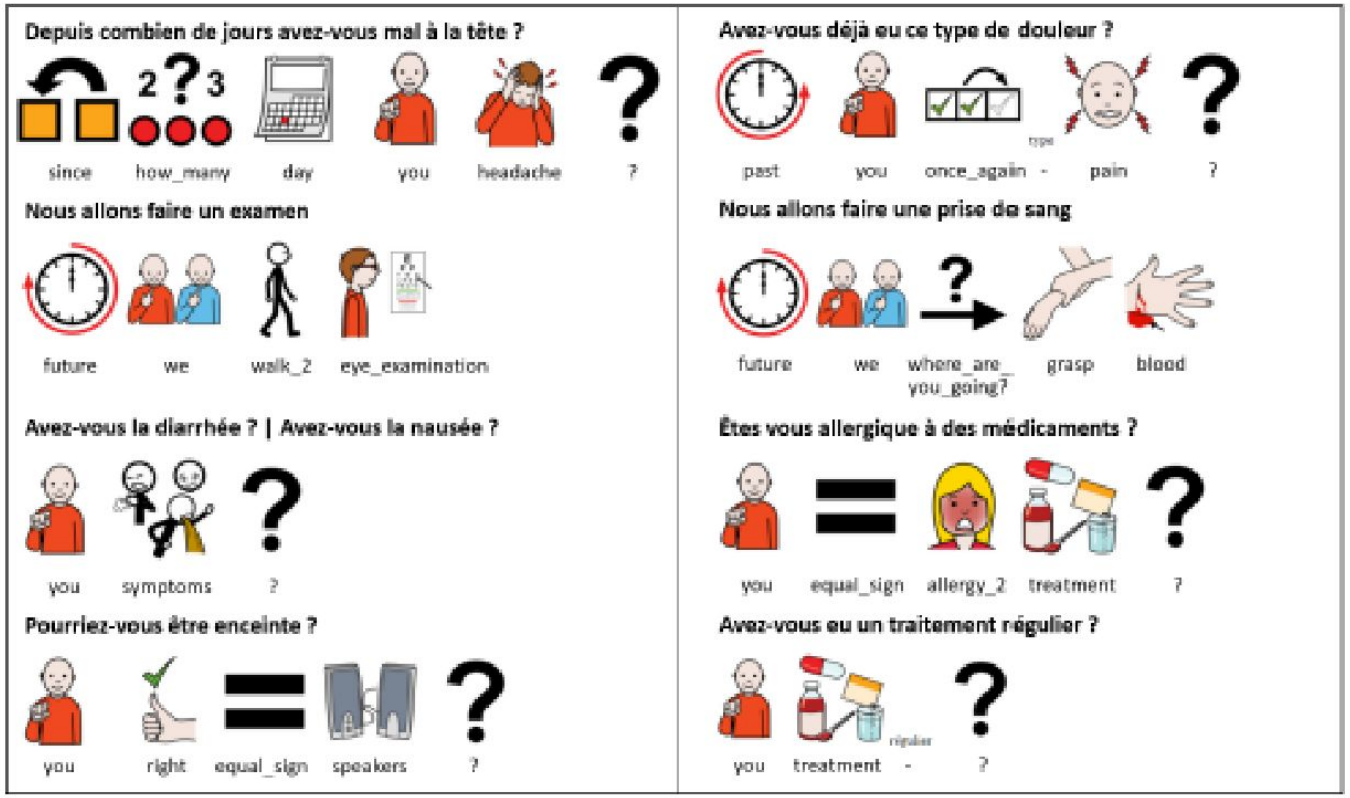


Figure 2: Examples of system's outputs in Arasaac.

GENERAL CONCLUSIONS

Up to now

- Large improvements over baseline
  - tested in vitro and in real user groups
  - adapted the system according to user feedback
  - make system usable in real life
    - For social network communication (WAI-NOT)
    - For medical communication
- Expansion to new languages
  - if there is a wordnet
  - if there are basic language tools
  - not too hard

Try it out

http://picto.ccl.kuleuven.be

Possible Assignments

- Write paper about how we could combine LLMs with the synsets that represent the meaning of the picto’s
- Train a new picto2text engine using transformers/pre-trained LMs
- …