

# A North Sámi to South Sámi machine translation prototype

Lene Antonsen,  
Giellatekno,  
Tromsø  
lene.antonsen@uit.no

Francis Tyers,  
Giellatekno,  
Tromsø  
ftyers@dlsi.ua.es

Trond Trosterud,  
Giellatekno,  
Tromsø  
trond.trosterud@uit.no

## Abstract

This paper describes the development of a rule-based machine translation system from North Sámi to South Sámi, and its evaluation in a setting where North Sámi functions as pivot translation via manual translation from Norwegian North Sámi, and thereafter MT to South Sámi.

## 1 Introduction

The paper presents a machine translation system from North Saami to South Saami. The system is intended to work in a translation setting where North Saami acts as a pivot language, with manual translation from Norwegian into the largest of the Saami languages, and thereafter to offer machine translation service, with postediting, to the other, smaller, Saami languages. On the one hand, the Saami languages are closely related, and therefore lend themselves better to MT than a system translating from Norwegian directly, but on the other hand, the classical problems of translating via a pivot language apply in this case as well.

The paper is structured as follows. After looking at previous work and at the languages themselves, we give a presentation of the actual machine translation system. Thereafter comes an evaluation of the system. We presented translated text to translators, alongside with the Norwegian original, without revealing the fact that the texts were actually translated from North Saami.

finally comes a conclusion.

Previous work

Tyers et al. (2009) and Wiechete et al. (2010) and Trosterud and Unhammer (2012)

LREC for numbers for the sme-analyser:

Lene Antonsen (2010)

pivot translation references –babych paper

Babych et al. (2007)

## 2 Motivation

sma sociolinguistic situation ?

## 3 Languages

As a Germanic language, Norwegian differs from the Saami languages in numerous respects. It has definiteness as a morphological category, no case, prepositions and verb / particle constructions, and a relatively strict word order, with V2 in main clauses. Norwegian and the Saami languages also show Sprachbund phenomena, though. Most notably, they have the same tense system. Whereas the Saami languages also possess a number of infinite verb construction, the Norwegian embedded clause pattern is in most cases a possible option for the Saami languages as well.

The Saami languages constitute the westernmost branch of the Uralic language family. They possess most of the classical Uralic characteristics: A rich verbal morphology (3 numbers and persons, a rich repertoire of infinite forms), and a medium-size case

system with both grammatical and adverbial functions, and no gender distinction. They also show extensive contact with their Germanic neighbours. Many grammatical structures are head-initial constructions, as compared to the classical Uralic pattern, and the tense system is compatible with the North Germanic one.

North and South Saami are not mutually intelligible, due both to linguistic distance and to radically different principles for their literary languages. An analogy would be the difference between English and Frisian.

Grammatical similarities between North and South Saami include the following: Both languages have 3 persons and numbers, they have a similar system for postpositions and verb derivation. Noun phrase syntax is similar, and the case systems are almost identical.

Taking a closer look, there are still differences. In both North and South Saami, negation is expressed with a negation verb which inflects for person and number, but in South Saami, this verb is inflected for Tense as well. South Saami has OV word order and lacks a copula in predicative constructions, whereas North Saami uses VO in simple sentences, and requires a copula. The possession construction is different from the Norwegian one, normally using copula rather than possessor subject + a verb *to have*. In North Saami, the construction is *locative possessor + copula + possessed in nominative*, whereas the possessor is in the genitive in South Saami.

Although the case systems are similar, North Saami has a locative case that covers the semantic field of both inessive and elative in South Saami, the locative must thus be split into two cases. There is also some differences in case usage, plural objects are accusative in North Saami, but nominative for indefinite and accusative for definite objects in South Saami.

For a machine translation system the orthographic differences imply that apart from person names and acronyms there will be no free rides during the conversion process. The core vocabulary is distinct, even recent loans from the same donor languages are

different, and the vocabulary coverage for a working system must thus be very good.

An overview over the differences between the two languages can be found in Sammallahti (1998).

## 4 Implementation

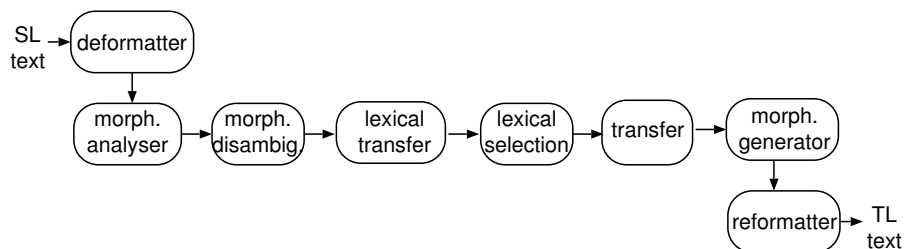
The translator was implemented using the Apertium platform Forcada et al. (2011). Apertium provides a highly modular set of tools for building rule-based machine translation systems. Apertium language pairs are set up as Unix pipelines, where the typical pipeline consists of:

- deformatting (encapsulating formatting/markup from the engine),
- source-language (SL) morphological analysis with a finite-state transducer (FST),
- disambiguation using a Hidden Markov Model (HMM) and/or Constraint Grammar (CG),
- lexical transfer (word-translation on the disambiguated source),
- lexical selection (choosing the appropriate word out of a set of possible translations),
- one or more levels of finite-state based structural transfer (reordering, and changes to morphological features),
- target-language (TL) generation with an FST
- reformatting (unencapsulating format information)

See Figure 1 for an overview of the modules used in this particular language pair.

### 4.1 Analysis

Morphological analysis is done on the input using the Helsinki Finite-State Toolkit Lindén et al. (2011).



**Figure 1:** Overview of the translation pipeline.

For each surface form, a finite-state transducer returns a set of the possible analyses, where an analysis is a combination of lemma, and a sequence of tags which describe the morphological structure of the surface form.

A Constraint Grammar-based disambiguator then selects the most appropriate analysis for each surface form according to the context, and assigns to each analysis a syntactic tag denoting its syntactic function (subject, object, main verb, ...).

The North Saami analyser has an F-score of 0.93 for morphological disambiguation and assignment of grammatical functions Lene Antonsen (2010).

## 4.2 Transfer

### 4.2.1 Lexical transfer

The bilingual dictionary: Some numbers

- 3,568 general word pairs + 61 proper nouns
- added: 873 special domain word pairs
- added: 10 721 proper nouns

There is no North Saami-South Saami dictionary, so we made one by making word pairs by combining the Norwegian words in a general North Saami-Norwegian dictionary and a general South Saami-Norwegian dictionary. The word pairs were manually edited and the work revealed many incorrect pairs because of Norwegian words with more than one meaning. Example is the Norwegian verb ‘regne’, which means both ‘to rain’ and ‘to calculate’, which are two different verbs both in North

Saami, *arvit* and *rehkenastit*, and in South Saami *abrodh* and *ryöknedh*. The result of this work was 3,568 general word pairs and 61 proper nouns.

The existing Norwegian-South Saami lexical resources are poor, with little terminology from the modern society. South Saami has been used more for giving information to the Saami people especially during the last two years, and there are some texts especially about school administration and curriculum on Internet. By comparing Norwegian texts with the translations to North Saami and South Saami, we added 873 special domain word pairs to the bilingual dictionary.

Large syntactic differences also have consequences for the bilingual dictionary, because many North Saami verbs have to be translated into South Saami as *object + verb* and *adverb + verb* strings. Examples include Norwegian ‘å trekke lodd’, («draw lots for») which is translated into North Saami as one verb *vuorbádit*, but into South Saami as object+verb *vuerpiem giesedh* (lit. «lot draw»).

Norwegian ‘å presentere’ is in North Saami *ov-danbuktit* but in South Saami *ávtese buektedh*. Often is the reason to this difference that one have utviklet North Saami terms to match the Norwegian terms, and in South Saami one still has to explain the meaning of the term with more words.

These are solved by adding giving the translation as MWE to the morphological analyser.

### 4.2.2 Lexical selection

Because we were adapting the MT system to a special domain, we only made xxx rules for lexical selection.

An MT-system for more domains, will certainly need more such rules.

The pivot model causes some extra lexical selection. Even if the lexical conceptualisation often is similar in South Saami and North Saami, as for the trivial ‘to rain, to calculate’ pair, there are also counter examples, like the Norwegian verbs ‘lese, telle, uttale’ («read, count, utter») which all three can be expressed with the North Saami verb *lohkat*. But in South Saami there is no common verb for these concepts, and the lexical distribution is like the one for Norwegian: *lohkedh, ryöknehtidh, jiehtedh*.

### 4.2.3 Structural transfer

The syntactic differences between North Saami and South Saami are greater than are usually dealt with between related language pairs in Apertium. In order to be able to transfer VO structures to OV more reliably, the transfer phase is split into five parts instead of the three more typically used in Apertium:

- chunker: Chunk input words into groups, e.g. noun groups, verb chains
- interchunk1: Merge chunks which have local coordination, e.g. the sequence [NP *x*] [CC and] [NP *y*] is merged into [NP *x* and *y*]
- interchunk2: Merges relative clauses and adpositional phrases.
- interchunk3: Reorder constituents, e.g. SVO → SOV.
- postchunk: Cleanup

### 4.2.4 Generation

Generation is done using a finite-state transducer, also compiled using HFST. Each lexical unit which is output by the postchunk module is looked up in the generation transducer and the surface form is output.

Here is some facts about the South Saami analyser, if we need it ?.

Bilingual dictionary (sme→sma)	15,204
Transfer rules (sme→sma)	57

**Table 1:** Number of bilingual dictionary entries and transfer rules

Corpus	Tokens	Coverage (%)
Schoolbooks	468,697	92.4 ± 0.58
General		0.0 ± 0.0

**Table 2:** Vocabulary coverage of the system

## 5 Evaluation

translation nob-sma which actually is nob-sme-sma (should somehow be in the title?) the evaluators evaluate nob-sma

We evaluate the system for both vocabulary coverage, and translation quality. For vocabulary coverage, we take two corpora, one in domain (schoolbooks) and one general domain.

For translation quality, we selected an text in the domain of school books. The text consisted of 300 words. This was then translated by the system and the resulting translation, and the Norwegian original was given to three translators. They were asked to postedit it to make an adequate South Sámi translation, and also to fill in a feedback questionnaire.

	Eval. A	Eval. B	Eval. C
<b>WER (%)</b>	62.37	49.46	52.69
<b>PER (%)</b>	36.20	28.32	28.32

**Table 3:** Evaluation metrics.

## 5.1 Statistics

## 5.2 Quantitative

WER – word error rate

## 5.3 Qualitative

### 5.3.1 Lexicon and morphology

The Norwegian text consisted of 288 words. The three evaluators had chosen respectively 42, 30 and 23 other words than the MT-system, for only for 9 words all the evaluators had chosen another word.

The morphology is quite good, but in four cases an incorrect or lack of disambiguation of the North Saami text has resulted in wrong morphological form to be generated. Some North Saami verbs require a certain case, which is not the right one for the corresponding South Saami verb.

### 5.3.2 Syntax

The evaluation revealed that the syntax was the poorest part of the MT-translation.

SOV: The evaluators used 10–12 SOV or SAdvIV constructions in their texts, in the MT-text there were only 4, because of ....

The MT-system generated only the construction *genitive possessor + copula + possessed in nominative* for possessive, but the evaluators preferred to some extent also using the verb *nominative possessor + utnedh + possessed in accusative*, one of the evaluators five times, the others twice. The MT-text didn't generate indefinite articles, but one of the evaluators used it six times, another one used it once and the last one didn't use it at all. In all cases there was an indefinite article in the Norwegian source text.

In North Saami there is no definiteness expressed in the morphology of the noun. But in South Saami it can be expressed in the object by choosing plural nominative instead of plural accusative. This is something which was not made rules for in the MT-system, and in one such case all the evaluators disagree with the MT-text.

A complement in Norwegian, like 'tilbud fra en lærebedrift' is usually in North Saami translated to a genitive modifier *oahppofitnodaga+Gen fálaldaga+Acc*, but in South Saami translations it is quite usual to translate it with a complement *faalenassem+Acc aktede+Art learoesieltete+Ela*, but we see from the translations that also the North Saami construction is possible: *learoesielten faalenassem*. Norwegian: tilbud (Obj) fra en lærebedrift 'offer from a xxxxcompany'

North Saami: *oahppofitnodaga+Gen fálaldaga+Acc*

South Saami 1: *faalenassem+Acc aktede+Art learoesieltete+Ela* South Saami 2: *learoesielten+Gen faalenassem+Acc*

From the oovast-presentation:

## 5.4 User feedback

## 6 Future work

## 7 Conclusions

reaction from sma linguist in the normgiving organ: she sees the possibility of using MT as a help for discussing terminology and getting the best ones into use

the language society is used to the impact from the majority languages, a new controversial(?) thought is the linguistic impact from another minority language

## Acknowledgements

Linda Wiecheteck, Divvun

## References

- Babych, B., Hartley, T., and Sharoff, S. (2007). Translating from under-resourced languages: comparing direct transfer against pivot translation. In *Proceedings of the MT Summit XI*, pages 29–35.

	MT	A	B	C
Lexical differences:		43	30	23
Morphological differences:		7	7	6
<b>Syntax</b>				
SOV/SAdvIV	4	10	12	12
Det pronomen	4	7	4	7
Ind. articles	0	6	0	1
Complement instead of genitive mod.	–	2	2	0
Habitative <i>utnedh</i>	0	5	2	2

**Table 4:** A break down of translation errors.

- Forcada, M. L., Ginestí-Rosell, M., Nordfalk, J., O'Regan, J., Ortiz-Rojas, S., Pérez-Ortiz, J. A., Sánchez-Martínez, F., Ramírez-Sánchez, G., and Tyers, F. M. (2011). Apertium: a free/open-source platform for rule-based machine translation. *Machine Translation*, 25(2):127–144.
- Lene Antonsen, Trond Trosterud, L. W. (2010). Reusing grammatical resources for new languages. In *Proceedings of LREC-2010*, Valetta, Malta. ELRA.
- Lindén, K., Silfverberg, M., Axelson, E., Hardwick, S., and Pirinen, T. (2011). *HFST—Framework for Compiling and Applying Morphologies*, volume Vol. 100 of *Communications in Computer and Information Science*, pages 67–85.
- Sammallahti, P. (1998). *The Saami Languages. An Introduction*. Davvi Girji.
- Trosterud, T. and Unhammer, K. B. (2012). Evaluating North Sámi to Norwegian assimilation RBMT. In *Proceedings of the Third International Workshop on Free/Open-Source Rule-Based Machine Translation (FreeRBMT 2012)*, number 2013:03, pages 13–26.
- Tyers, F., Wiecheteck, L., and Trosterud, T. (2009). Developing prototypes for machine translation between two sámi languages. In *Proceedings of the 13th Annual Conference of the European Association for Machine Translation, EAMT09*, pages 120–128.
- Wiecheteck, L., Tyers, F., and Omma, T. (2010). Shooting at flies in the dark: Rule-based lexical selection for a minority language pair. *Lecture Notes in Artificial Intelligence*, 6233:418–429.