

LING 120:
Language and Computers
Semester: Fall '17

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Today's class

- ▶ How does Machine Translation work?
- ▶ A small exercise

Recap of what we discussed about MT last week

Applications of Machine Translation

- ▶ creating multi-lingual interfaces to software
- ▶ translating news, weather reports etc
- ▶ support tool while traveling to a foreign country
- ▶ while learning a new language

Challenges in Machine Translation

- ▶ How words are formed between languages
- ▶ What is the order of words
- ▶ Words that don't seem to translate
- ▶ Words that seem to come up in translation that do not exist in original
- ▶ Language specific issues that are sometimes not translatable
- ▶ Getting the right sense of meaning in translation
- ▶ Stylistic, cultural differences
- ▶ Metaphor, poetry etc.

n-grams in MT: question from few classes back

- ▶ Map phrases in one language to another
- ▶ Decide what is the most appropriate ordering of words in the translated output, what is grammatical, what is more natural for that language etc

How is MT software created? How does it work?

Translation using examples

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- ▶ Let us say we initially compile a lot of sentences translated by humans from one language to another (English to German).
- ▶ We are asked to now translate this sentence: "The FX380B has a color LCD screen and an automatic rangefinder."
- ▶ ... and we have human translated versions for:
 1. The ZX65 **has a color LCD screen**
⇒ Die ZX65 **hat einen LCD-Farbbildschirm.**
 2. The FX809 has a 4 cm screen **and** a flashgun.
⇒ The FX809 hat einen 4cm-Bildschirm **und** ein Blitzgerät.
 3. The larger model has **an automatic rangefinder.**
⇒ Das größere Modell verfügt über **einen automatischen Enternungsmesser.**
- ▶ From these examples, we can stitch together a possible translation for the new sentence. (HOW?)

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Translation using examples -2

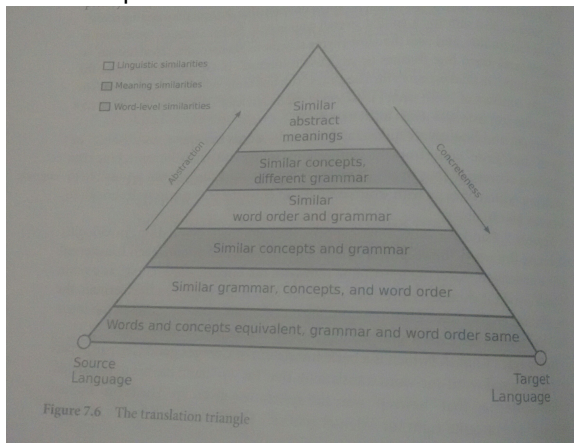
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- ▶ If my translation is about a x-ray manual, I need to super careful about its accuracy.
- ▶ If am using it just as a tourist on a mobile phone, may be it is okay to not have that final human checker (It is quite expensive to have someone do it all the time!)

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- ▶ If am using it just as a tourist on a mobile phone, may be it is okay to not have that final human checker (It is quite expensive to have someone do it all the time!)
- ▶ Thus, what is "good enough" translation depends on the application.

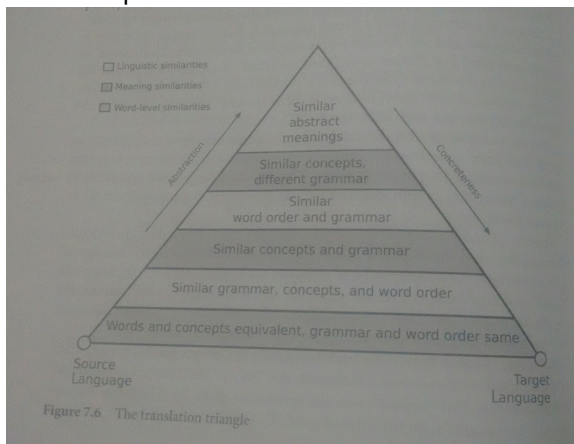
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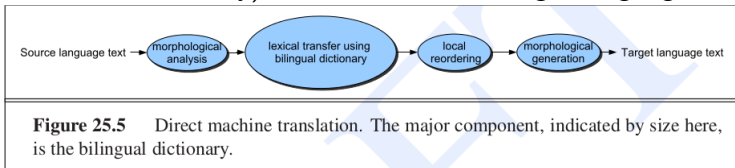
Different possibilities:



Translation gets easier as you move higher in level of abstraction. But getting that representation is harder.

Direct MT

Collect dictionaries, rules about word formation (and reordering suffixes etc correctly) etc for source and target languages.



Direct MT-2

```
function DIRECT_TRANSLATE_MUCH/MANY(word) returns Russian translation
if preceding word is how return skol'ko
else if preceding word is as return stol'ko zhe
else if word is much
    if preceding word is very return nil
    else if following word is a noun return mnogo
else /* word is many */
    if preceding word is a preposition and following word is a noun return mnogii
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```

Main challenge with this approach?

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Main challenge with this approach? - Word order, reordering is difficult.

Syntactic Transformation based MT

Alternative to Direct MT: Operate at the level of syntax.

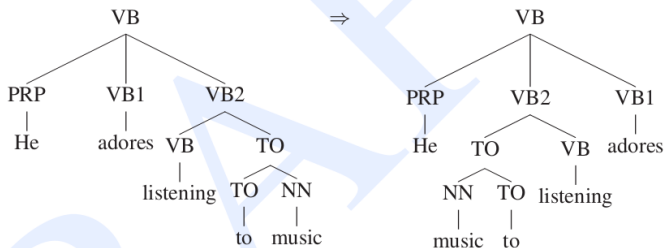


Figure 25.12 The result of syntactic transformations from English order (SVO) to Japanese order (SOV) for the sentence *He adores listening to music* (*kare ha ongaku wo kiku no ga daisuki desu*), after Yamada and Knight (2001). This transform would require rules for moving verbs after their NP and VP complements, and changing prepositions to postpositions.

Main challenges: How will we know the word level translations, morphological information etc?

Combining both ideas

It is ofcourse a good idea to combine direct MT with syntactic rules based MT.

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Main challenge with this approach ? -Doing this for each and every language pair!

Statistical MT

- ▶ Modern MT is statistical and data driven i.e., it is based on:
 - ▶ Collecting lot of parallel sentences between any two pairs
 - ▶ "learning" to align words and phrases between a source-target sentence pair
 - ▶ "learning" the probabilities of word level and phrase level translations
 - ▶ "learning" reordering and where to place a translated phrase in the process
 - ▶ Combining all these steps to ensure translation is accurate and it is also natural in target language.

Issues involved

- ▶ How to represent sentences? How to align them in an optimal way (there are so many permutations and combinations when we don't even have a dictionary!)
- ▶ Where do we get so much of data for any two arbitrary languages?
- ▶ If we do sentence by sentence, how do we maintain overall text coherence?
- ▶ If there a way to do MT via a pivot language? i.e., if I want German to Italian, but I have German to English and English to Italian, can I use those together?

etc etc

Noisy Channel idea for statistical MT

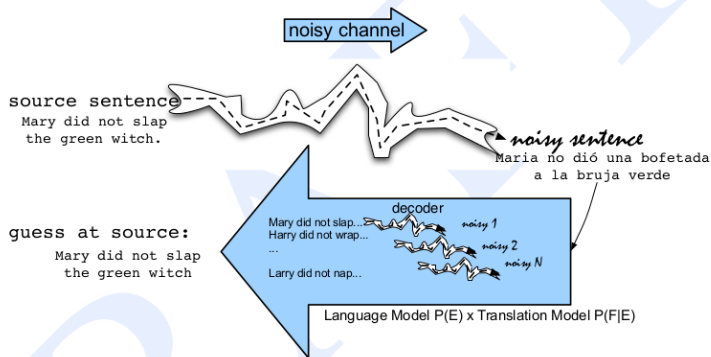


Figure 25.15 The noisy channel model of statistical MT. If we are translating a source language French to a target language English, we have to think of 'sources' and 'targets' backwards. We build a model of the generation process from an English sentence through a channel to a French sentence. Now given a French sentence to translate, we pretend it is the output of an English sentence going through the noisy channel, and search for the best possible 'source' English sentence.

Attendance Exercise on MT

There is a small news article in English and Indonesian versions. They are not parallel versions, but are comparable. Read the article and answer the questions in the next page. You can work individually or in groups - up to you. This is how computers learn to create training data and learn to translate, btw. By looking at thousands and thousands of articles like this.