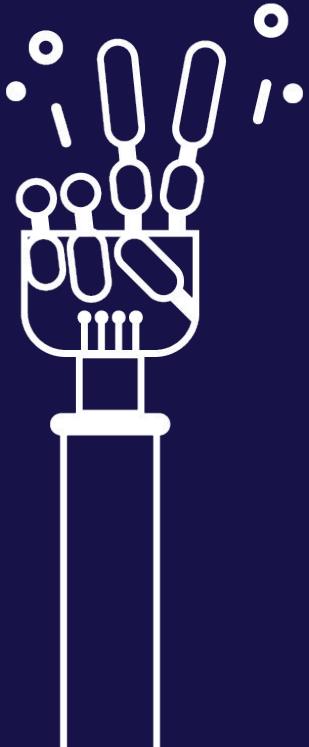


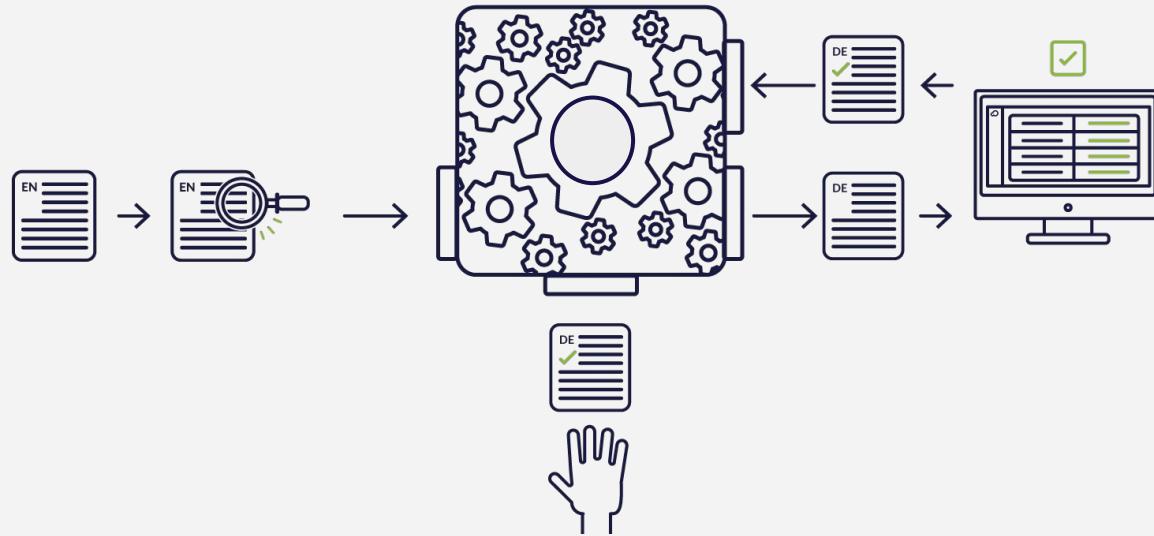
Term-Aware Machine Translation

Svetlana Tchistiakova

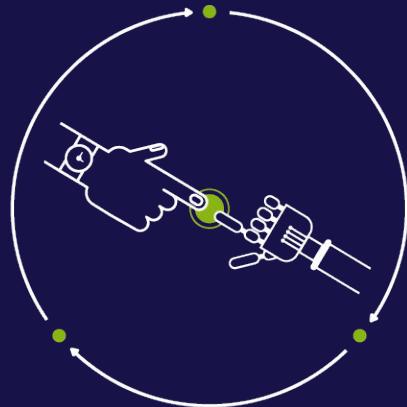


Outline

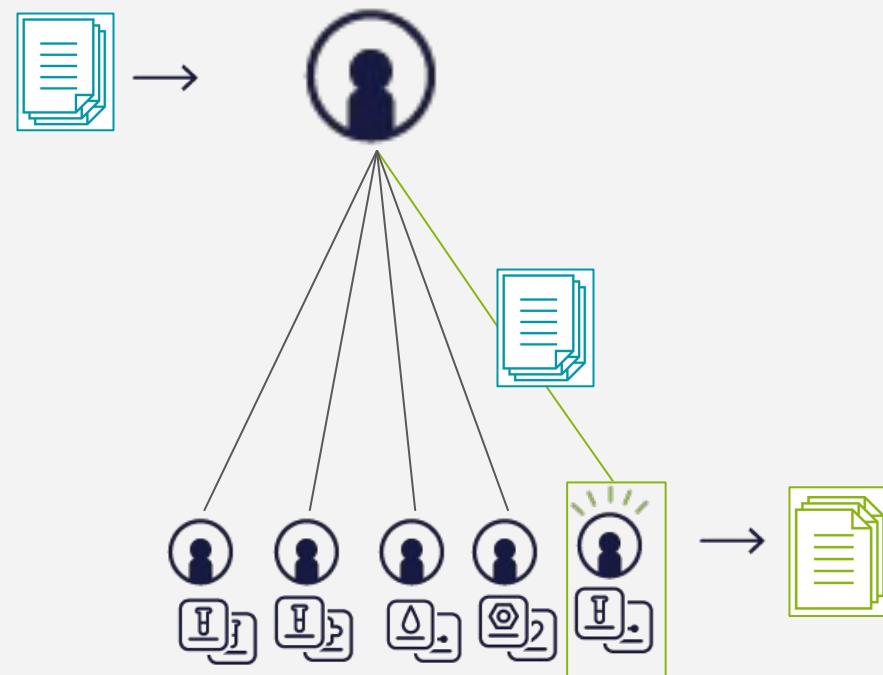
- Business Process Automation
- Term Search
- Term Integration
- Our Implementation



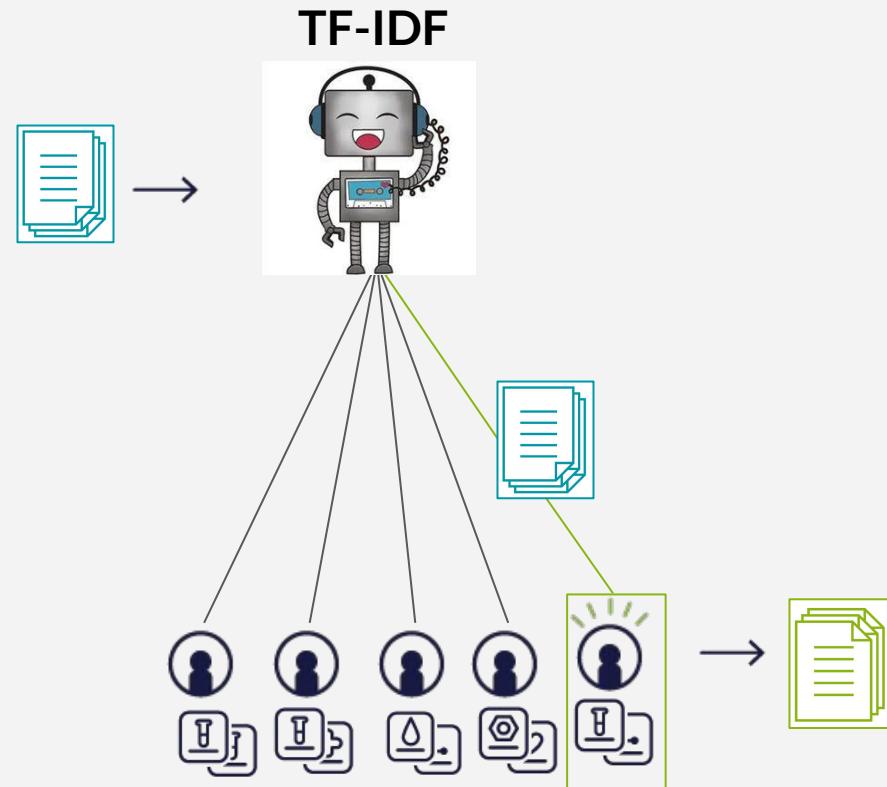
Business Process Automation



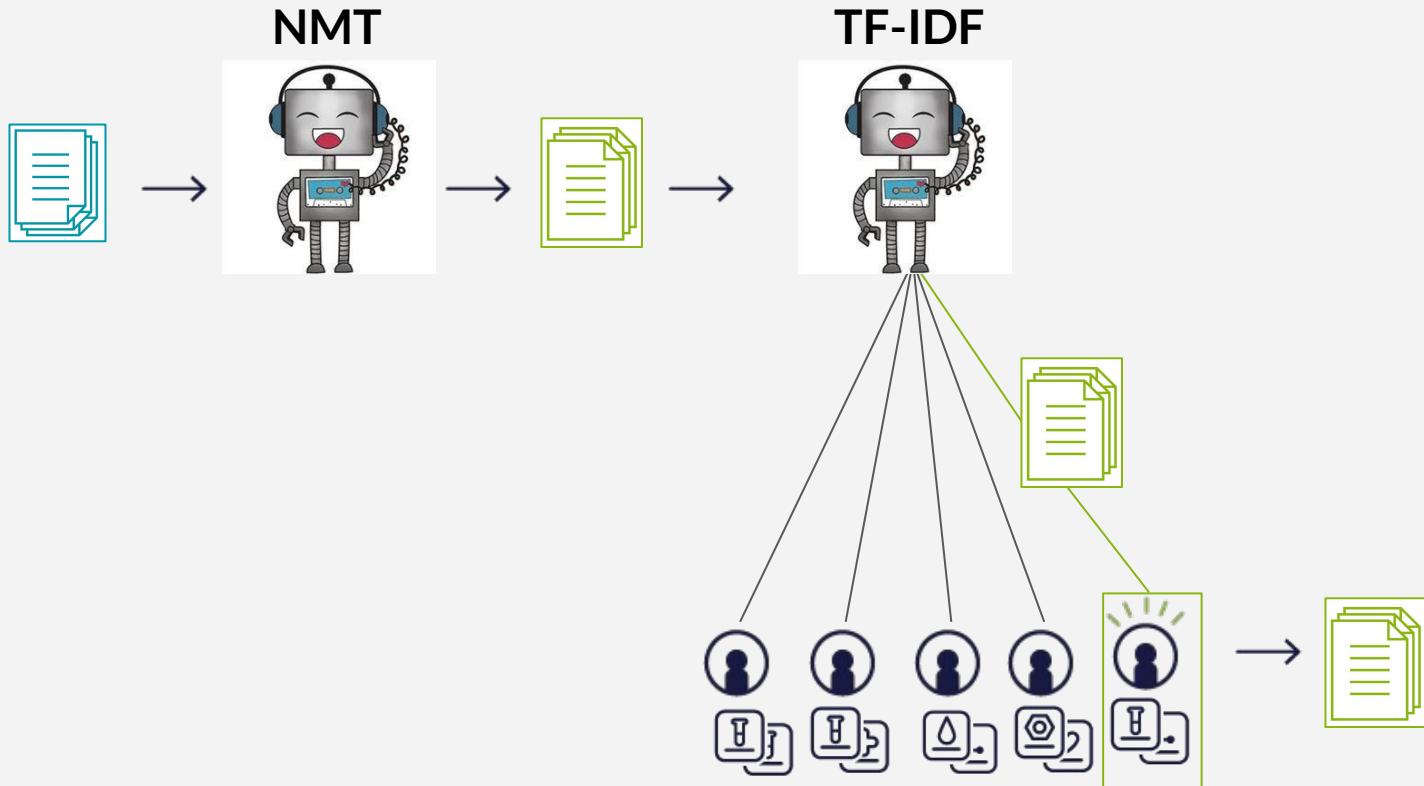
Automate Translation



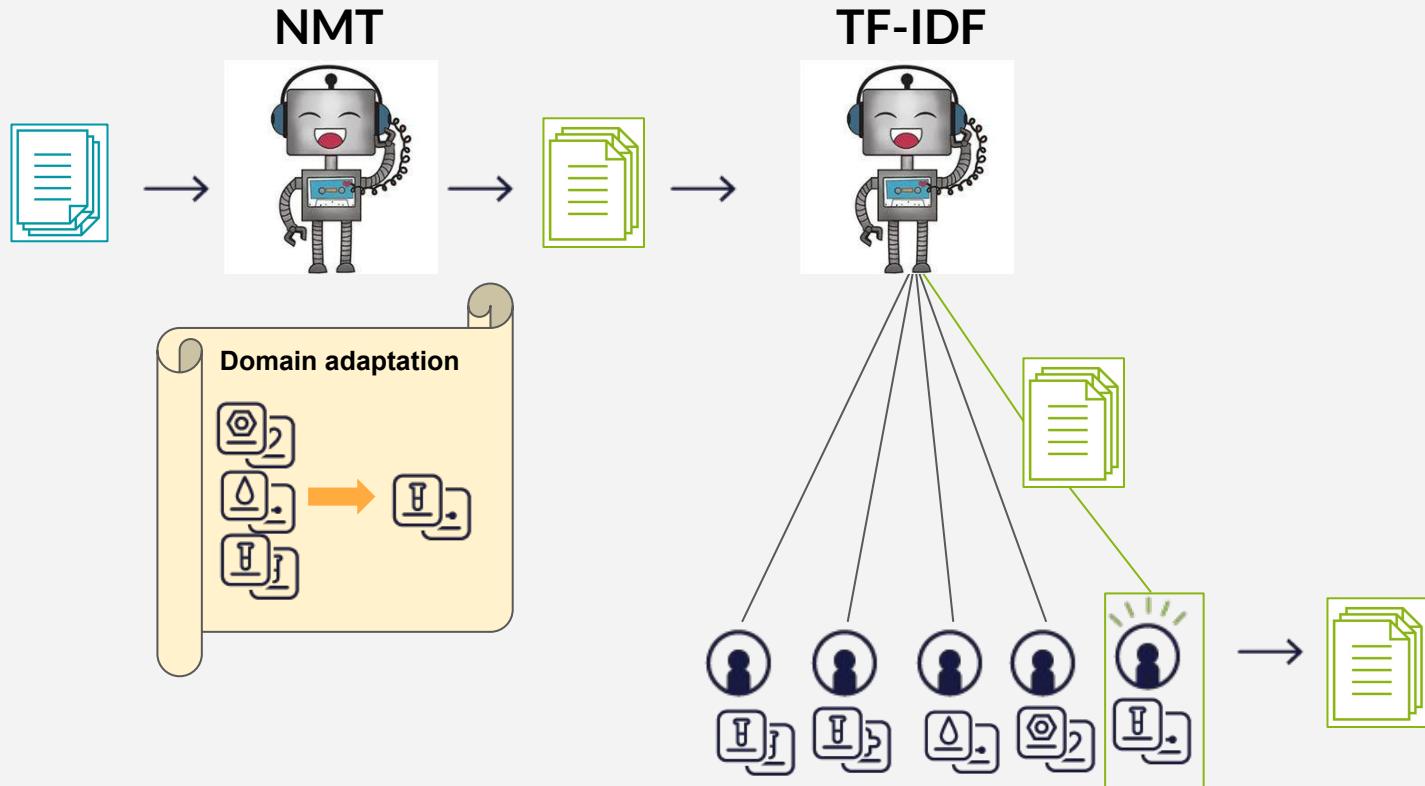
Automate Translation



Automate Translation



Automate Translation



Source search

DEAL OF THE MONTH, SAVE UP TO 10%* WORLDWIDE

#2

#3

#4

1 Get ready for our Deal of the month February: save up to 10%* on your next car rental worldwide.

Target search

ANGEBOT DES MONATS, SPAREN SIE WELTWEIT BIS ZU 10% *

1 Seien Sie ...

Last Saved: 17.04.2020 07:30 pm
Origin: TM_DELETED

{...} DONE

Translation Matches	Glossary	History	Validations
96% <bx id="1"/>Get ready for our Deal of the month February: save up to 10%* on your next car rental worldwide. <bx id="1"/>Machen Sie sich bereit für unseren Deal des Monats Februar: Sparen Sie bis zu 10% * bei Ihrem nächsten Auto Vermietung weltweit.			Created by you a few seconds ago
96% <bx id="1"/>Get ready for our Deal of the month February: save up to 10%* on your next car rental worldwide.			Created by you 3 hours ago

Source search

DEAL OF THE MONTH, SAVE UP TO 10%* WORLDWIDE

#2

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Translation Matches 3 Glossary History 13 Validations

96% <bx id="1"/>Get ready for our Deal of the month February: save up to 10%* on your next car rental worldwide.
<bx id="1"/>Machen Sie sich bereit für unseren Deal des Monats Februar: Sparen Sie bis zu 10% * bei Ihrem nächsten Auto Vermietung weltweit.

Created by you
a few seconds ago

Created by you
3 hours ago

Glossary

[IMPORT A FILE](#)

+ Add a filter

Reset Filters X

GermanEnglishFrenchAll Glossary Files

German	French ↓	English
Schritte bis zum Kauf	étapes jusqu'à l'achat	steps to purchase
Schritt 1	étape 1	step 1
Fairness	équité	fairness
Pre-Selection-Team	équipe présélection	Pre-Selection Team
Shop Roll-Out Team	équipe Shop Roll-Out	-
Folge einer Serie	épisode d'une série	-
Touchscreen	écran tactile	touchscreen
Erfassungsmaske	écran de saisie	input screen
Loginmaske	écran de connexion	login screen

Rows per page:251-25 of 1571<>

Challenges

1. Term Search: How to find terms from the glossary in the source-language sentence
2. Term Integration: How to make the MT model use the correct term

Term Search



Term Search Strategies

	Word Formation	Synonymy & Paraphrasing
Fuzzy matching (e.g. Levenshtein)	<ul style="list-style-type: none">- Only captures small differences- Highly error prone	<ul style="list-style-type: none">- Not handled
Lemmatization	<ul style="list-style-type: none">- Morph. handled for same part-of-speech	<ul style="list-style-type: none">- Not handled
Word embedding similarity	<ul style="list-style-type: none">- Little issue with word forms	<ul style="list-style-type: none">- Similar word-senses grouped together- Needs tuned thresholds and prone to the hubness problem

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Expectation

```
Original glossary: {  
    "aussteigen": ["disembark"],  
    "das Handelsabkommen": ["trade deal", "trade agreement"]  
}
```

Zielperson ist ausgestiegen.
Target has disembarked.

Wir bitten alle Passagiere, hier auszusteigen.
All passengers please disembark.

Alle, die an dieser Mission nicht beteiligt sind, steigen jetzt aus!
Anyone not part of this mission, disembark now!

Bitte bereiten Sie sich für den Ausstieg vor.
Please stand by to disembark.

Die UNO ist besorgt wegen des Handelsabkommens.
UN representatives are concerned it could delay the trade agreement.

Der Abschluss des Freihandelsabkommens mit Mexico
The conclusion of the association agreement with Mexico

Reality

```
Lemmatized glossary: {  
    "aussteigen": ["disembark"],  
    "der Handelsabkommen": ["trade deal", "trade agreement"]  
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morphology

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syntax

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Anyone not part of this mission , stay back now!

paraphrase

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morphology

Die UNO ist besorgt wegen des Handelsabkommens.
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compound

Der Abschluss des Freihandelsabkommens mit Mexico
The conclusion of the association agreement with Mexico

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syntax

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paraphrase

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Please stand by to disembark.

morphology

Die UNO ist besorgt über den Abschluss des Handelsabkommens.
UN worried about the conclusion of the trade agreement.

compound

Der Abschluss des Freihandelsabkommens mit Mexico
The conclusion of the association agreement with Mexico

Reality

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Lemmatized glossary: {  
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Der Abschluss des Freihandelsabkommens mit Mexico
The conclusion of the association agreement with Mexico

Reality (w/ Oracle for training data)

```
Lemmatized glossary: {  
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synonymy

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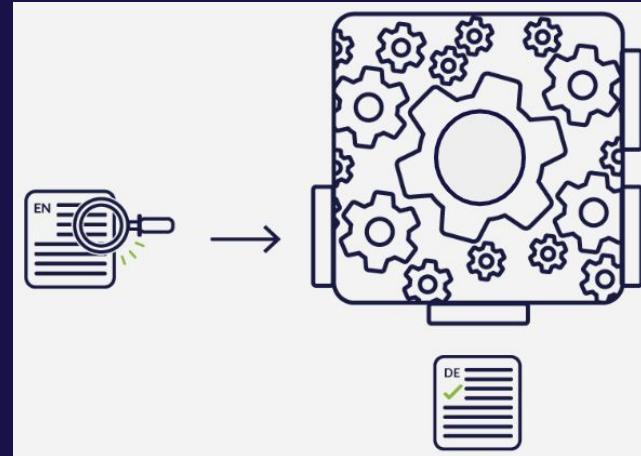
Bitte bereit ich sich für der Ausstieg vor .
please stand by to disembark .

Oracle selects
translation to use

der UNO sein besorgen wegen der Handelsabkommens .
UN representative be concern -PRON- could delay the trade agreement .

der Abschluss der Freihandelsabkommens mit Mexico
the conclusion of the association agreement with Mexico

Term Integration



Approach 1: Constrained Decoding

Lexically Constrained Decoding for Sequence Generation Using Grid Beam Search

Chris Hokamp

ADAPT Centre

Dublin City University

chris.hokamp@computing.dcu.ie

Abstract

We present Grid Beam Search (GBS), an algorithm which extends beam search to allow the inclusion of pre-specified lexical constraints. The algorithm can be used with any model that generates a sequence $\hat{y} = \{y_0 \dots y_T\}$, by maximizing $p(\hat{y}|\mathbf{x}) = \prod_t p(y_t|\mathbf{x}; \{y_0 \dots y_{t-1}\})$. Lexical constraints take the form of phrases or words that must be present in the output sequence. This is a very general way to incorporate additional knowledge into

Guiding Neural Machine Translation Decoding with External Knowledge

Rajen Chatterjee^(1,2), Matteo Negri⁽²⁾, Marco Turchi⁽²⁾,
Marcello Federico⁽²⁾, Lucia Specia⁽³⁾, and Frédéric Blain⁽³⁾

⁽¹⁾University College Dublin
⁽²⁾Fondazione Bruno Kessler
⁽³⁾University of Edinburgh
{chatterje, m.negri, m.turchi, m.federico, l.specia}@fbk.eu
{l.specia}@ed.ac.uk

Abstract

Differently from the previous paradigm, neural machine translation (NMT) operates on word and phrase representations in a continuous space. This makes the decoding process more difficult to interpret, but easier to influence with external knowledge. To solve the latter problem, effective solutions use the XML-markup used by neural models to inject fixed transla-

Fast Lexically Constrained Decoding with Dynamic Beam Allocation for Neural Machine Translation

Matt Post and David Vilar

Amazon Research

Berlin, Germany

Abstract

The end-to-end nature of neural machine translation (NMT) removes many ways of manually guiding the translation process that were available in older paradigms. Recent work, however, has introduced a new capability: *lexically constrained* or *guided* decoding, a modification to beam search that forces the inclusion of pre-specified words and phrases in the output. However, while theoretically sound, existing approaches have computational complexities that are either linear

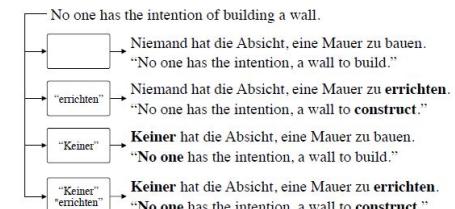


Figure 1: An example translating from English to German. The first translation is unconstrained, whereas the remaining ones have one or two constraints im-

Approach 1: Constrained Decoding

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⁽³⁾UCL

{ chatterje
{ 1.specia
{ 1.blain

Abstract

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- Post-processing method
- Decoder is forced to include the terms, which can result in overuse or ungrammatical insertions
- Word formation must be handled after the constraints are satisfied

of neural machine translation process that paradigm. Recent introduced a new capability or guided beam search that specified words and phrases in the output. However, while theoretically sound, existing approaches have computational complexities that are either linear

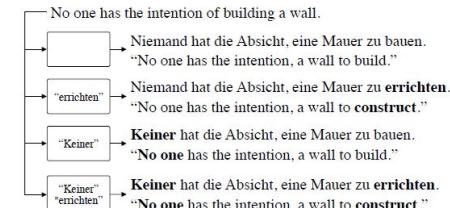


Figure 1: An example translating from English to German. The first translation is unconstrained, whereas the remaining ones have one or two constraints im-

Approach 2: Training with Terminology

Training Neural Machine Translation To Apply Terminology Constraints

Georgiana Dinu

Prashant Mathur

Marcello Federico

Yaser Al-Onaizan

Amazon AI

{gddinu, pramathu, marcfcde, onaizan}@amazon.com

Abstract

This paper proposes a novel method to inject custom terminology into neural machine translation at run time. Previous works have mainly proposed modifications to the decoding algorithm in order to constrain the output to include run-time-provided target terms. While being effective, these constrained decoding methods add, however, significant computational overhead to the inference step, and, as we show in this paper, can be brittle when tested in realistic conditions. In this paper we

have been significant work on proposing methods to integrate domain terminology into NMT at run time.

Constrained decoding is the main approach to this problem. In short, it uses the target side of terminology entries whose source side match the input as decoding-time constraints. Constrained decoding and various improvements were addressed in Chatterjee et al. (2017), Hasler et al. (2018), Hokamp and Liu (2017) among others. Hokamp and Liu (2017) recently introduced the grid beam search (GBS) algorithm which uses a

Approach 2: Training with Terminology

Training Neural Machine Translation To Apply Terminology Constraints

Georgiana Dinu

Prashant Mathur

Marcello Federico

Yaser Al-Onaizan

Amazon AI

{gddinu, pramathu, marcfcde, onaizan}@amazon.com



- Data and training augmentation (train with terms)
- Model learns a mechanism that works with any glossary at inference time
- Word formation left up to the model
- Model may choose not to use the term

tested in realistic conditions. In this paper we

significant work on proposing methods to incorporate domain terminology into NMT at run

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Hokamp and Liu (2017) recently introduced the grid beam search (GBS) algorithm which uses a

Approach 2: Training with Terminology

```
Original glossary: {  
    "gehen": ["walking"],  
}
```

Ich gehe zum Laden.

```
Lemmatized glossary: {  
    "gehen": ["walk"],  
}
```

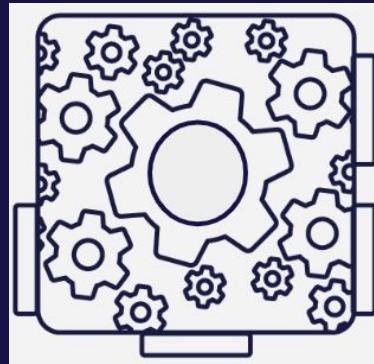
ich gehen zu Laden .

Desired MT output: I'm walking to the store.

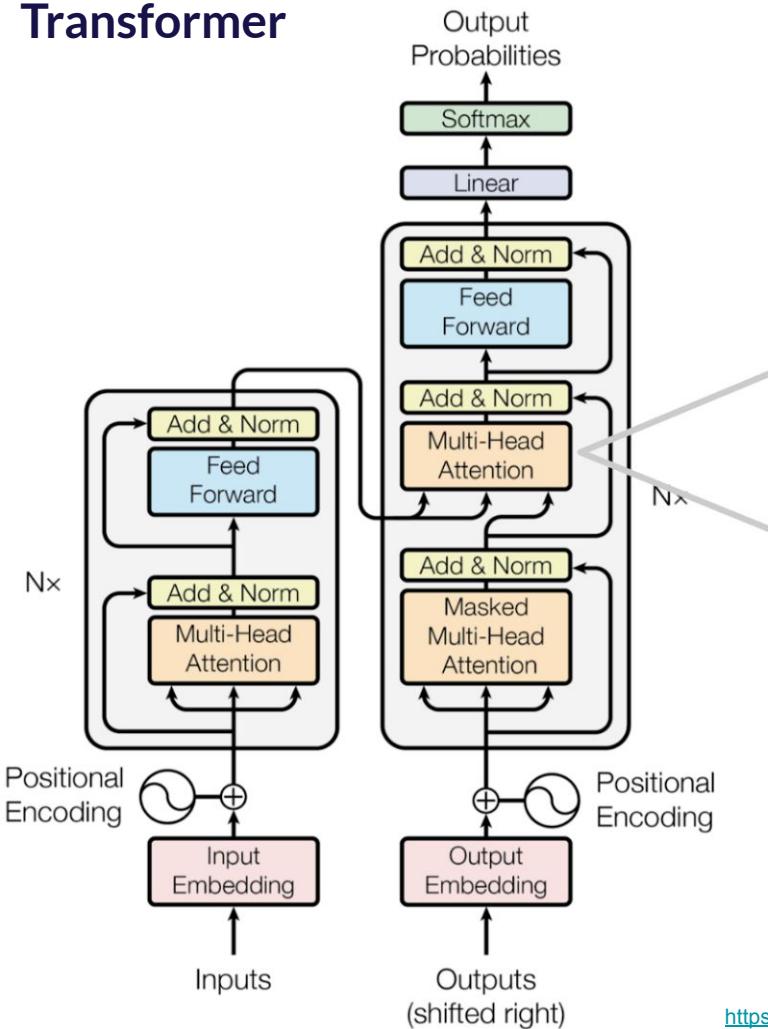
Augmented Source: Ich gehe walk zum Laden.

Source factors: 0 1 2 0 0

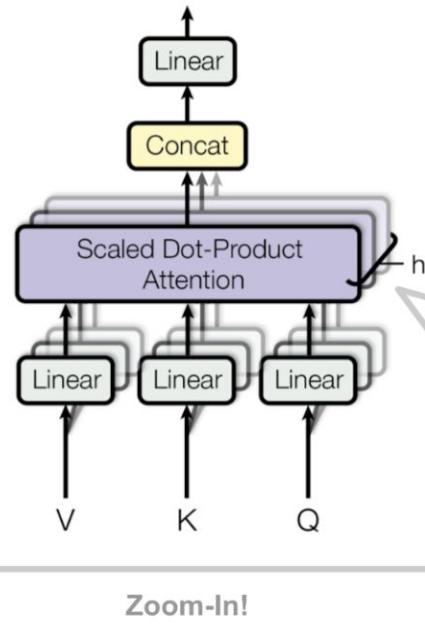
Our Implementation



Transformer

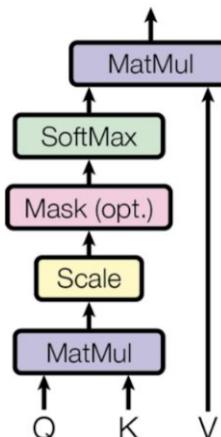


Multi-head attention



- Transformer BASE size
- Batch size: 4096 tokens
- Max length: 99 tokens
- Initial LR: 0.0003
- Using Sockeye from AWS

Scaled dot-product attention



Byte-pair encoding preprocessing

u-n-r-e-l-a-t-e-d
u-n re-l-a-t-e-d
u-n re-l-at-e-d
u-n re-l-at-ed
un re-l-at-ed
un re-l-ated
un rel-ated
un-related
unrelated

Benefits:

- Handles complex word-formation strategies
- Handles unknown words
- Lowers vocab size

Our model:

- Shared source+target model
- Vocab size: 32k
- Using SentencePiece

Lemmatizer

spaCy

GET STARTED

[Installation](#)

Models & Languages

- Quickstart
- Language Support
- Installation & Usage
- Production Use

Facts & Figures

[spaCy 101](#)

New in v2.2

New in v2.1

New in v2.0

GUIDES

[Linguistic Features](#)

[Rule-based Matching](#)

[Processing Pipelines](#)

[Vectors & Similarity](#)

[Training Models](#)

[Saving & Loading](#)

[Adding Languages](#)

[Visualizers](#)

IN-DEPTH

USAGE MODELS

Models & Languages

spaCy's models can be installed as **Python packages**. This means that they're a component of your application, just like any other module. They're versioned and can be defined as a dependency in your `requirements.txt`. Models can be installed from a download URL or a local directory, manually or via [pip](#). Their data can be located anywhere on your file system.

Quickstart

Install a default model, get the code to load it from within spaCy and an example to test it. For more options, see the section on available models below.

Language	English	German	French	Spanish	Portuguese	Italian
Dutch	Greek	Norwegian Bokmål	Lithuanian			

<https://spacy.io/>

30

Terminology Bank Data



European Union terminology

Search 🔍 ⓘ

Last Queries (+) ✖ Reset Search settings Open expanded search ⬇️

* Source language ▲

bg	cs	da	de	el	en	es	et	fi	fr	ga	hr	hu	it
lt	lv	mt	nl	pl	pt	ro	sk	sl	sv	la	mul		

* Target language ▲

bg	cs	da	de	el	en	es	et	fi	fr	ga	hr	hu	it
lt	lv	mt	nl	pl	pt	ro	sk	sl	sv	la	mul		

Searches last week
983 182

Number of terms
7 969 805

Number of entries
971 972

Modifications last week
27 009

New terms last week
3 755

Terms deleted last week
1 483

About IATE

IATE (Interactive Terminology for Europe) is the EU's terminology database. It has been used in the EU institutions and agencies since summer 2004 for the collection, dissemination and management of EU-specific terminology. The project was launched in 1999 with the aim of providing a web-based infrastructure for all EU terminology resources, enhancing the availability and standardisation of the information.

ⓘ About IATE ? FAQ
 Download IATE IATE brochure

<https://iate.europa.eu/home>

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Parallel Sentence Data

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OPUS is a growing collection of translated texts from the web. In the OPUS project we try to convert and align free online data to provide the community with a publicly available parallel corpus. OPUS is based on open source products and the corpus is a package. We used several tools to compile the current collection. All pre-processing is done automatically. No manual correction.

The OPUS collection is growing! Check this page from time to time to see new data arriving ...

Contributions are very welcome! Please contact <jorg.tiedemann@helsinki.fi>

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Search & Browse

Sub-corpora (downloads & infos):

- OPUS multilingual search interface
- Europarl v7 search interface
- Europarl v3 search interface
- OpenSubtitles search interface
- OpenSubtitles 2018 search interface
- EUconst search interface
- Word Alignment Database (old DB)
- ada83 - Ada 83 manuals
- Bianet - Translated Turkish articles
- Bible (uedin) - Collection of Bible translations
- Books - A collection of translated literature
- CAPES - Thesis and dissertation abstracts
- DGT - A collection of EU Translation Memo
- DOGC - Documents from the Catalan Gover

(Specifically: Europarl, GlobalVoices, Gnome, OpenOffice, OpenSubtitles, Paracrawl, PHP, Tatoeba, Ted2013.)

- 58.5 mil DE → EN parallel sentences:
- Removed pairs where:
 - The pair is a duplicate
 - Longer than 1k characters
 - Not English/German
 - Lengths differ by 3x
 - Target is the same token repeated 3x
 - >70% not alphanumeric
 - Empty source or target
- Trained for 500k updates, i.e. 86% through epoch 2 (counting from 0)

Our Prototype!

The screenshot shows a Streamlit application interface with a browser-like header.

Translation languages

Choose translation direction:
de->en

Glossary

Don't Use Glossary

Choose a CSV file

Drop files here to upload
or
[browse files](#)

[Load Glossary](#)

Add term

de
Katzen

en
dogs

[Add](#)

Translate

Source text:
Ich mag die Katzen.

[Translate](#)

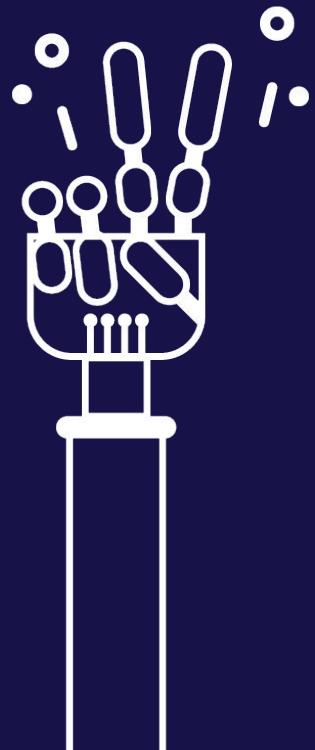
I like the dogs.

Glossary

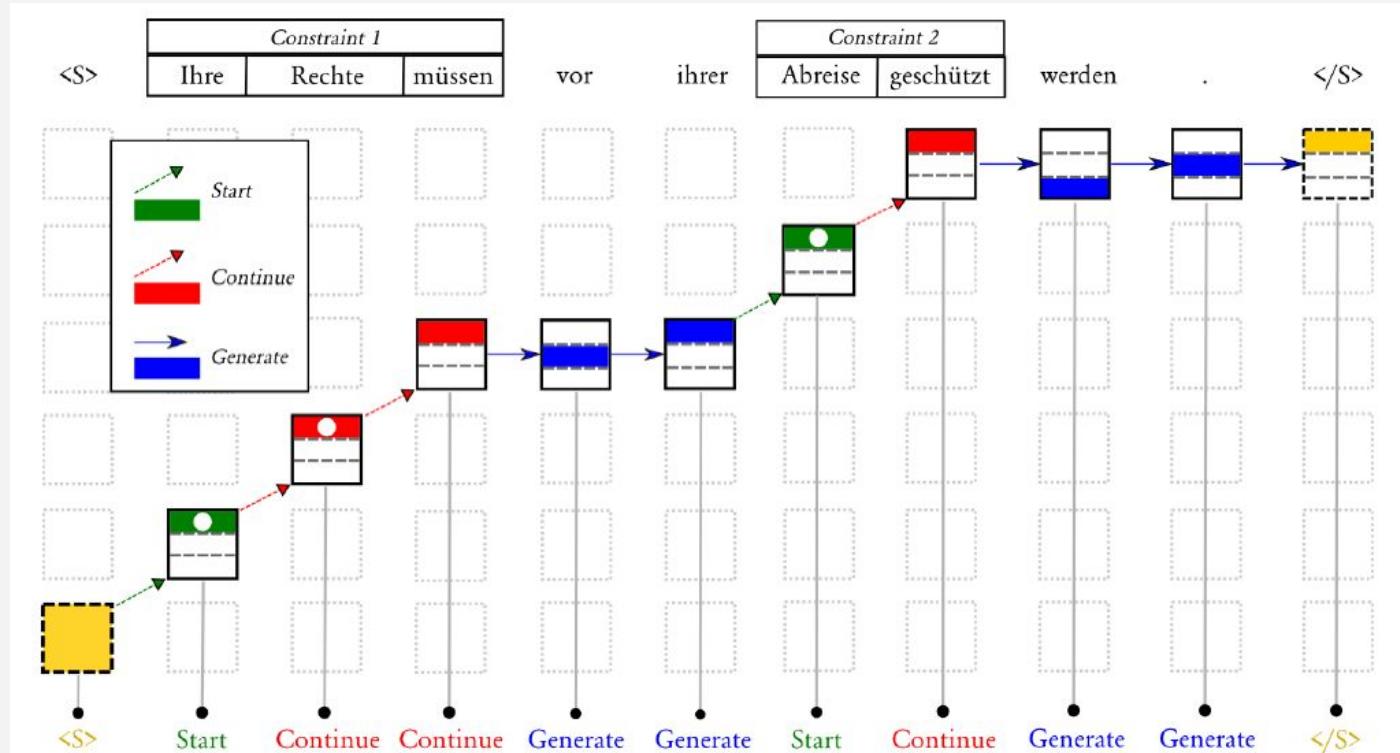
	de	en
θ	Katze	{'dog'}

Made with Streamlit

Thanks for your
attention!

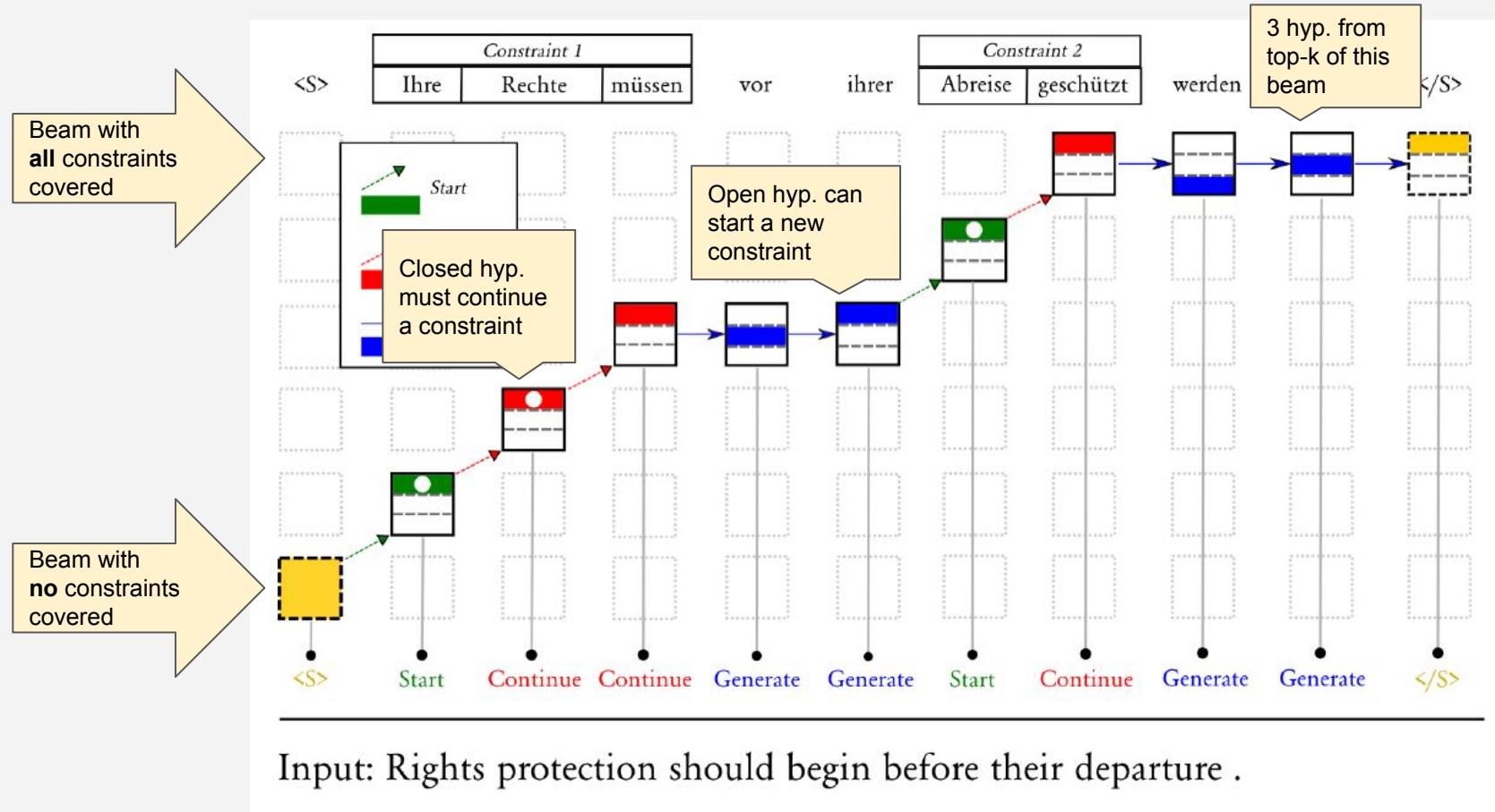


Approach 1: Constrained Decoding



Input: Rights protection should begin before their departure .

Approach 1: Constrained Decoding

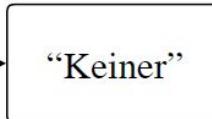


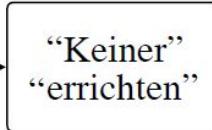
Using the Term in the Output

No one has the intention of building a wall.

 → Niemand hat die Absicht, eine Mauer zu bauen.
(No one has the intention, a wall to build.)

 → Niemand hat die Absicht, eine Mauer zu **errichten**.
(No one has the intention, a wall to construct.)

 → **Keiner** hat die Absicht, eine Mauer zu bauen.
(Nobody has the intention, a wall to build.)

 → **Keiner** hat die Absicht, eine Mauer zu **errichten**.
(Nobody has the intention, a wall to construct.)

Term Search Challenges

international agreement [INTERNATIONAL RELATIONS
trade policy (2006) [TRADE]

de

Handelsabkommen

en

trade agreement

trade deal

EU-Marokko Handelsabkommen in Kraft getreten

EU-Marocco trade agreement has entered into force

des Freihandelsabkommens zwischen der EU und den USA

of the EU-US trade deal

Der Abschluss des Freihandelsabkommens mit Mexico

The conclusion of the association agreement with Mexico

Term Search Challenges: Word Formation

Domain code not specified (00)

de repatriieren

en repatriate

vertriebene Frauen, repatriierte Frauen
displaced women, repatriated women

nicht zwangsrepatriiert werden
are not forcefully repatriated

Ich war sofort verletzt und wurde repatriiert.
I was injured on day one and repatriated.

Term Search Challenges: Word Formation

Domain code not specified (00)	
de	repatriieren
en	repatriate

vertriebene Frauen, repatriierte Frauen
displaced women, repatriated women

nicht zwangsrepatriiert werden
are not forcefully repatriated

Ich war sofort verletzt und wurde repatriiert.
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Term Search Challenges: Synonymy

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	trade deal

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Term Search Challenges: Paraphrasing

air transport [TRANSPORT > air and space transport]	
de	aussteigen
en	disembark

Alle Fahrgäste bitte aussteigen.

All passengers, please disembark at this time.

Bitte bereiten Sie sich für den Ausstieg vor.

Please stand by to disembark.

Und die armen Teufel alle ausschiffen.

Gotta disembark these poor sods.

Sie können hier von Bord gehen.

Officers, you can disembark here.

Term Search Challenges: Paraphrasing

air transport [TRANSPORT > air and space transport]	
de	aussteigen
en	disembark

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Outline

- Business Process Automation
- Term Search
- Term Integration
- Our Implementation

