OpenNMT: Open-Source Toolkit for Neural Machine Translation

Guillaume Klein†, Yoon Kim*, Yuntian Deng*, Jean Senellart†, Alexander M. Rush*
Harvard University*, SYSTRAN †

Competitive system

OpenNMT implements models and training procedures that achieve competitive results in system comparison, e.g. in the recent WMT 2017 translation task:

System	BLEU-cased
uedin-nmt-ensemble	28.3
LMU-nmt-reranked-wmt17-en-de	27.1
SYSTRAN-single	**26.7**

Table: Top 3 on English-German *newstest2017*.

More generally, OpenNMT produces strong baselines with optimized training time and memory requirements.

System	Training (WPS)	Inference (WPS)	BLEU
Nematus	3221	252	18.25
OpenNMT	5254	457	19.34

Table: Comparison of source words per second (WPS).

Features

OpenNMT implements many additional features on top of the standard sequence-to-sequence model:

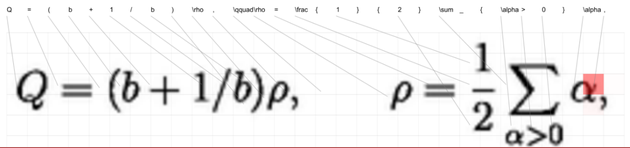
- factored translation for richer text representation;
- tokenization and data preparation tools;
- model variants: bidirectional encoder, convolutional encoder, variational dropout, etc.;
- learning rate decay strategies;
- advanced model retraining and adaptation;
- beam search normalization;
- ... and many more!

Other tasks

OpenNMT supports other tasks than machine translation:

- Sequence tagging.
- Language modeling.
- Speech-to-text, using a pyramidal RNN encoder.
- Image-to-text, using a combination of CNN and RNN layers.

For example, *Im2Text* (github.com/OpenNMT/Im2Text) is an extension that can be used for image captioning, optical character recognition, or LaTeX decompilation:



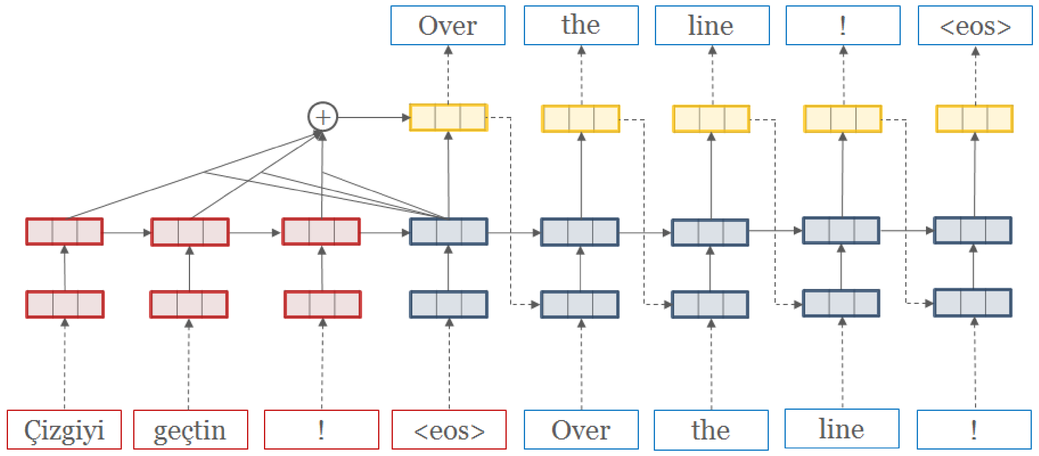


Figure: The standard sequence-to-sequence model.

OpenNMT is an industrial-strength and open-source neural machine translation ecosystem featuring:

- Ready-to-use and highly configurable implementations in *Torch* and *PyTorch*.
- State-of-the-art translation accuracy and competitive training efficiency.
- Standalone and dependency-free inference engine in C++.
- Extensive set of model and training options covering a large set of needs of academia and industry.
- Extensions to allow other sequence generation tasks such as summarization, image-to-text, and speech-to-text.

Approach

Neural machine translation (NMT) is a new methodology for machine translation that has led to remarkable improvements, particularly in terms of human evaluation, compared to rule-based and statistical machine translation (SMT) systems.

OpenNMT implements the attention-based encoder-decoder architecture that models the probability of a target sentence $w_{1:T}$ given a source sentence $x_{1:S}$ as:

$$p(w_{1:T}|x) = \prod_{1}^{T} p(w_t|w_{1:t-1}, x; \theta)$$

This modeling is usually achieved using LSTM recurrent networks which allows long term dependency learning.

Technologies

OpenNMT is an ecosystem based on multiple technologies and frameworks:

- OpenNMT: the original full-featured project in *LuaTorch*, focusing on maintainability, user support, and production.
- OpenNMT-py: a *PyTorch* clone of OpenNMT, focusing on research and modularity.
- CTranslate: an inference engine for OpenNMT models in C++ and *Eigen*, focusing on embedded and production environments.

Additional resources

OpenNMT provides additional resources including:

- A complete documentation portal (opennmt.net/OpenNMT) for beginners to advanced users describing data preparation, models, training strategies, command line options, etc.
- Visualization tools for debugging or understanding.

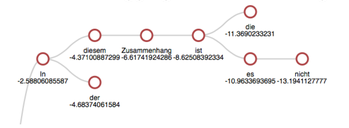


Figure: Beam search visualization

Production

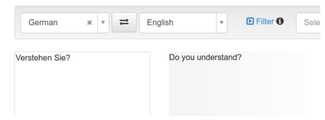


Figure: Live demo of OpenNMT

OpenNMT has proved to be adapted to production settings. SYSTRAN—a major translation services provider—is using OpenNMT for its Pure Neural™ Machine Translation offering which enables higher translation quality in existing services.

Community

OpenNMT is also a community around machine translation and language modeling. The forum (forum.opennmt.net) counts more than 200 users with daily questions on how to improve or adapt their system and training procedure.

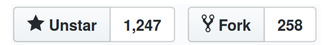


Figure: GitHub statistics as of July 18th, 2017.

A user survey showed that users are equally coming from industry and academia, proving that the framework is well suited for many use cases.

Open-source landscape

There exist several open-source alternatives that maintain a healthy competition and collaboration. Notable mentions are:

- *Nematus* (github.com/EdinburghNLP/nematus)
- *Marian NMT* (marian-nmt.github.io)
- *Neural Monkey* (github.com/ufal/neuralmonkey)
- *seq2seq* (google.github.io/seq2seq)