Empirical evaluation of NMT and PBSMT quality for large-scale translation production.

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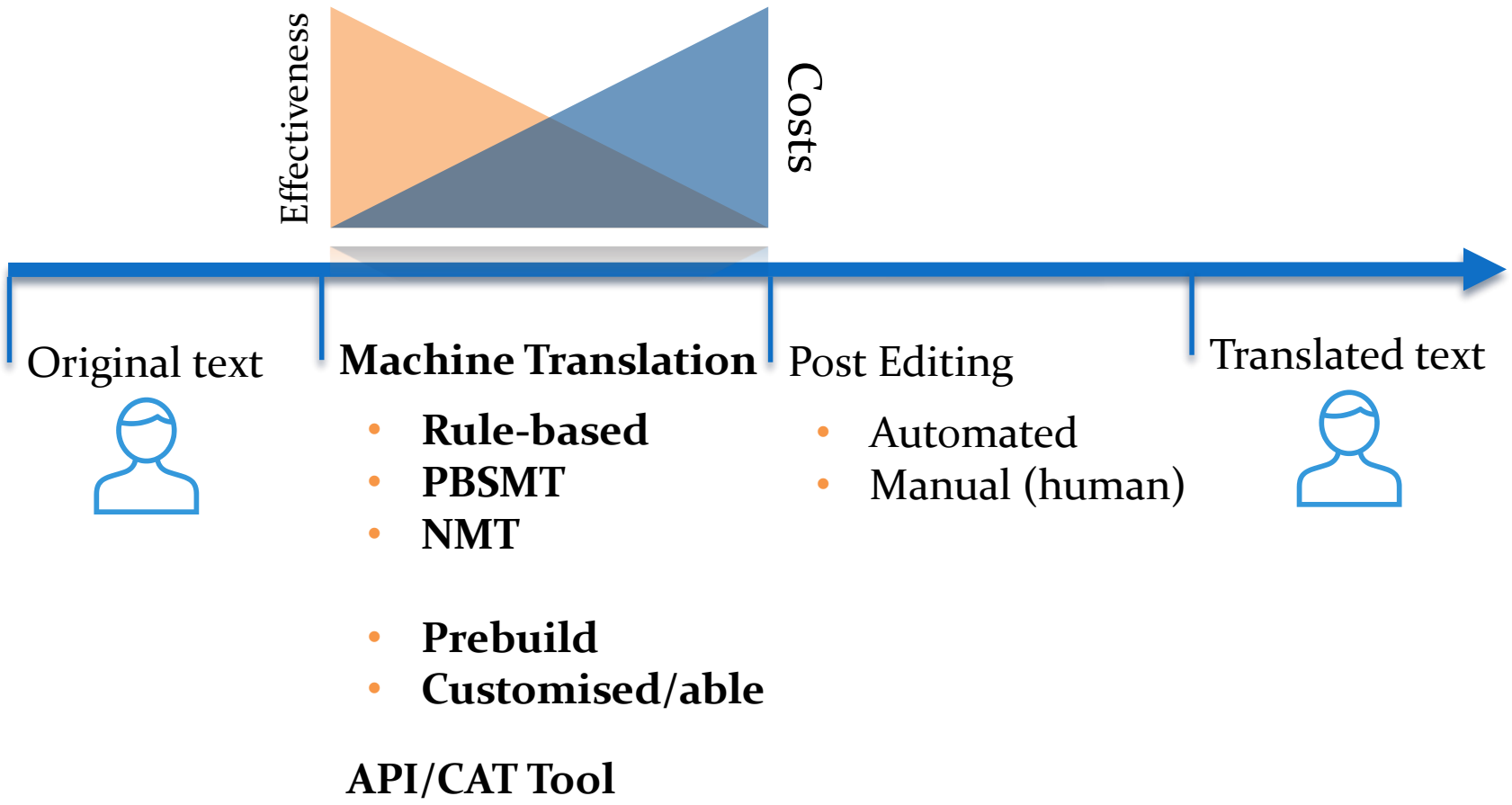
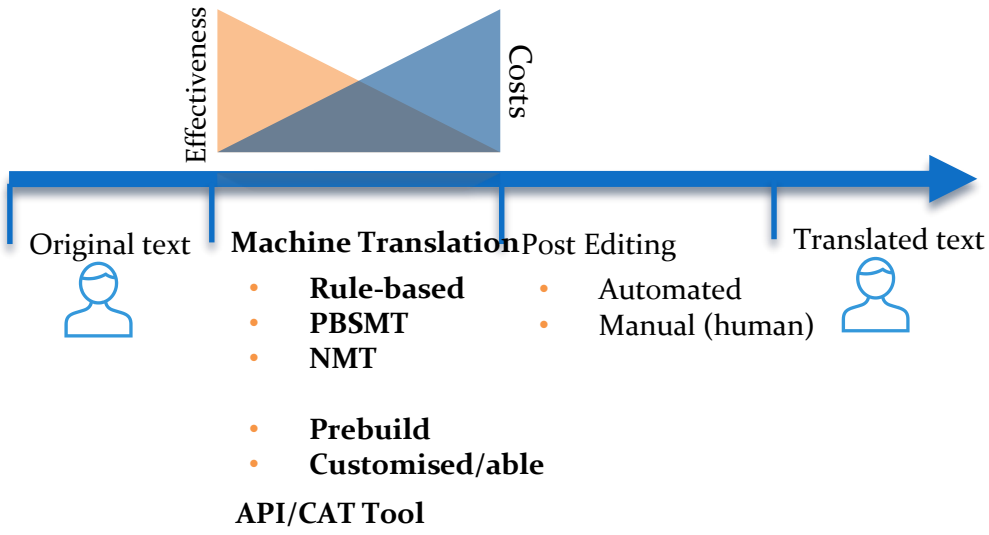
MT-centric translation production line



MT-centric translation production line

- **Can NMT be better than PBSMT?**



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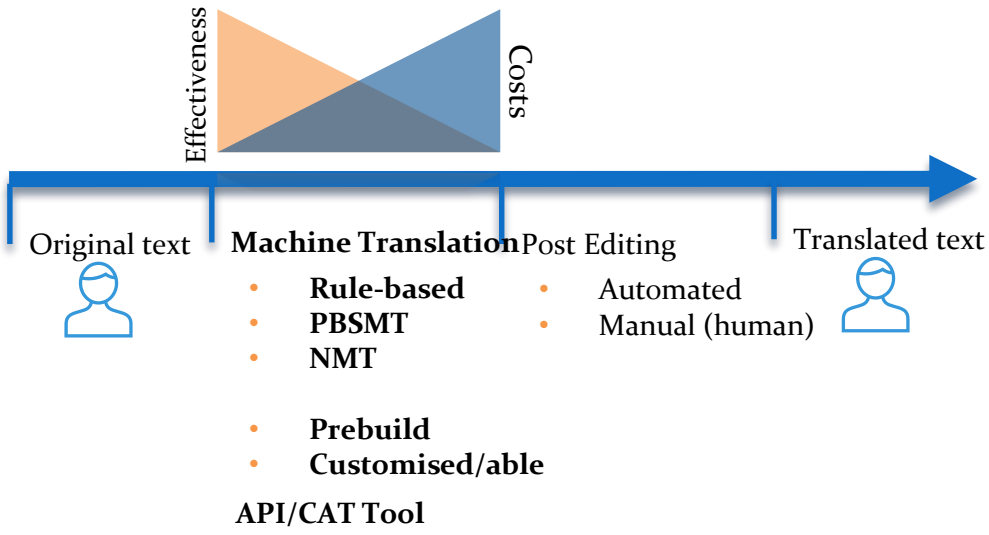
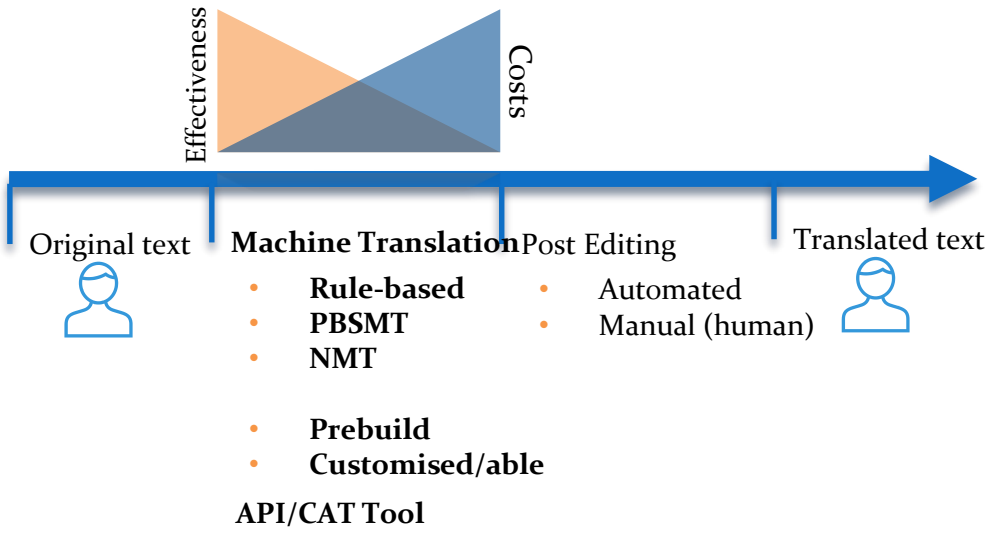
- **Can NMT be better than PBSMT?**
- **How to evaluate and compare MT quality?**

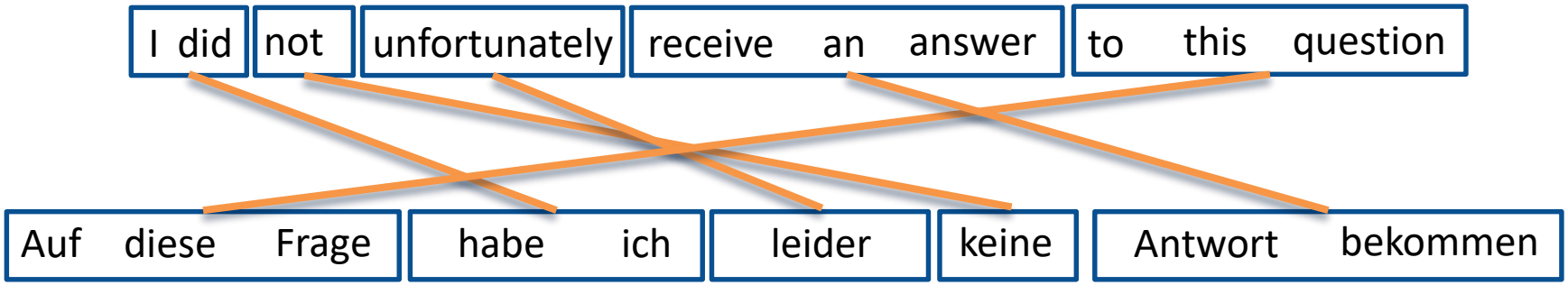


MT-centric translation production line

- **Can NMT be better than PBSMT?**
- **How to evaluate and compare MT quality?**
- **Is NMT feasible for a large-scale translation production?**



Phrase-based Statistical MT

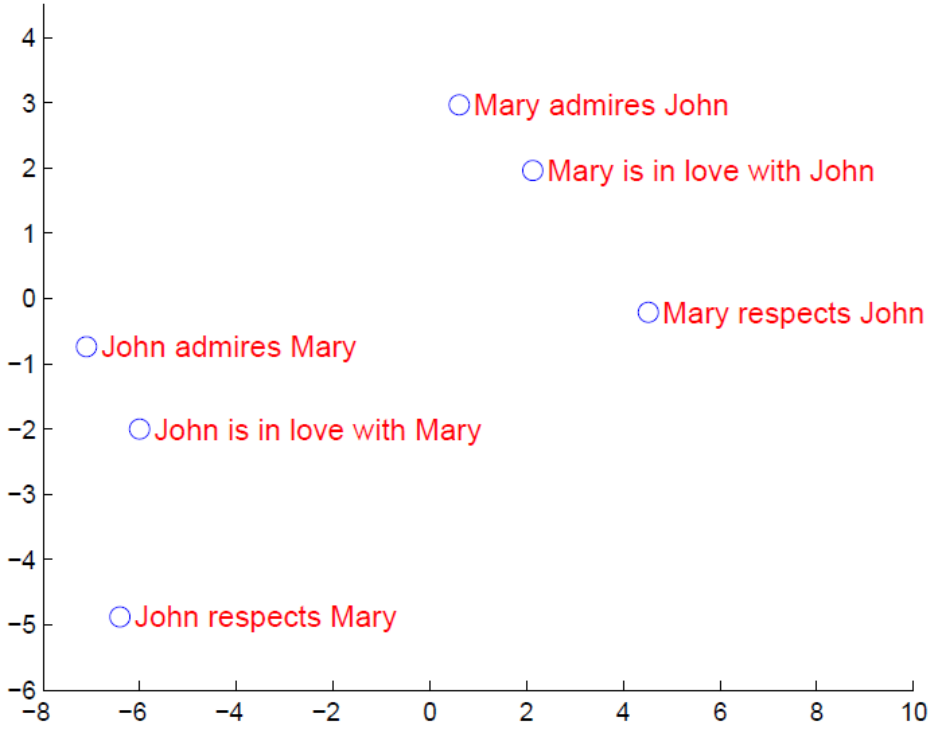


- **Multiple components, sequentially connected**
  - Translation model
  - Language model
  - Recasing model
- **Translation**
  - A phrase translation is derived from the phrase table
  - Language and recasing models add meaning

…
I did→hebe ich
I did→ich hebe
Unfortunately→leider
Unfortunately→unglücklich
Receive an asnwer→emfange eine Antwort
Receive an answer→Antwort bekommen
Receive an answer→Antwort erhalten
…

Neural MT

- **Encode-decoder neural network**
  - Two connected RNNs .
  - Trained simultaneously to maximise performance.
- **Training/Translation**
  - A source sentence is encoded ***(summarised)*** as a vector ***c.***
  - Words segmented in word-units
  - The decoder predicts a word from ***c*** and already predicted words.



[Sutskever 2014] Ilya Sutskever, Oriol Vinyals, Quoc V. Le, **Sequence to Sequence Learning with Neural Networks**

NMT vs. PBSMT

- PBSMT considers phrases (1-grams … n-grams); all phrases.
- NMT handles the sentence as a whole.
- PBSMT will translate each phrase or leave them untranslated.
- NMT will aim to translate everything; "unknown" will replace untranslatable.
- PBSMT is more literal – can be more accurate.
- NMT can be more fluent – can be completely inaccurate.
- PBSMT is transparent -- easy to tamper with and improve.
- NMT is a "black box".

- PBSMT and NMT are both data-driven MT paradigms.

Empiritical evaluation

- **Quality evaluation metrics**
  - BLEU
  - F-Measure
  - TER
- **Human evaluation:**
  Side-by-side comparison

What is BLEU? (Papineni et al., 2002)

- Measures the precision of an MT system.
- Compares the n-grams ($n \epsilon \{1..4\}$) of a candidate translation with those of the corresponding reference.
- The more n-gram matches the higher the score.
- Can be document- or sentence- level
- Factors for BLEU
  - Translation length
  - Translated words
  - Word order

[Papineni et al. 2002] Papineni, Kishore, Salim Roukos, Todd Ward, and Wei-Jing Zhu. **BLEU: A Method for Automatic Evaluation of Machine Translation.** In ACL 2002.

An example…

- **Source (EN):**

  All dossiers must be individually analysed by the ministry responsible for the economy and scientific policy.

- **Translations (DE):**

  1. Jeder Antrag wird von den Dienststellen des zuständigen Ministers für Wirtschaft und Wissenschaftspolitik individuell geprüft.
  2. Alle Unterlagen müssen einzeln analysiert werden von den Dienststellen des zuständigen Ministers für Wirtschaft und Wissenschaftspolitik.
  3. Alle Unterlagen müssen von dem für die Volkswirtschaft und die wissenschaftliche Politik zuständigen Ministerium einzeln analysiert werden.

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1. Jeder Antrag wird von den Dienststellen des zuständigen Ministers für Wirtschaft und Wissenschaftspolitik individuell geprüft.

PBSMT BLEU 58%

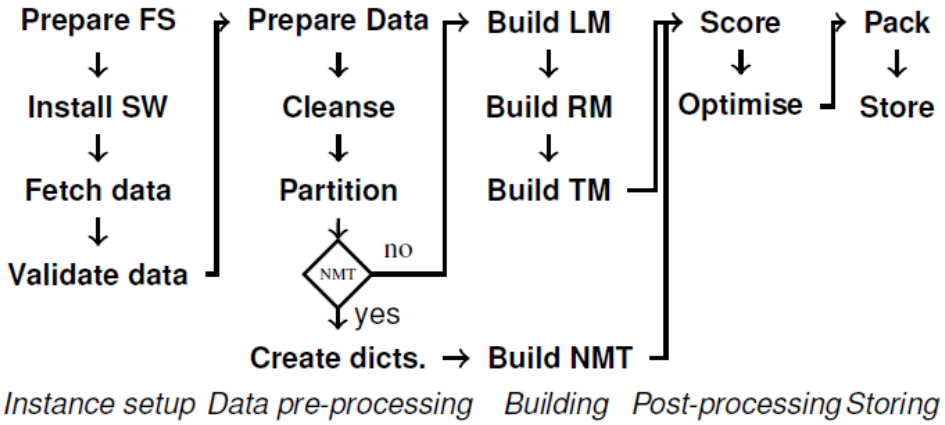
2. Alle Unterlagen müssen einzeln analysiert werden von den Dienststellen des zuständigen Ministers für Wirtschaft und Wissenschaftspolitik.

NMT BLEU 0%

3. Alle Unterlagen müssen von dem für die Volkswirtschaft und die wissenschaftliche Politik zuständigen Ministerium einzeln analysiert werden.

Empirical evaluation

- **Data:**
  - EN-DE (8,820,562), EN-ES (3,681,332), EN-IT (2,756,185), EN-JA (8,545,366), EN-ZH-CN (6,522,064)
  - Locked train, tune, test data
- **Systems:**
  - PBSMT: Moses, CPU, FA, 5-gram LM, tuned 25 iter.
  - NMT: OpenNMT, GPU NVIDIA K520, ADAM, 0.0005, batch: 64



- **Restrictions on the NMT training:**
  - For no longer than 4 days
  - Perplexity needs to be bellow 3

Empirical evaluation

- **Automatic quality evaluation:**
  - BLEU
  - F-Measure
  - TER

Empirical evaluation

- **Automatic quality evaluation:**
  - BLEU
  - F-Measure
  - TER

	PBSMT				NMT				
Lang. pair	F-Measure	BLEU	TER	T	F-Measure	BLEU	TER	P	T
EN-DE	62	53.08	54.31	18	62.53	47.53	53.41	3.02	92
EN-ZH-CN	77.16	45.36	46.85	6	71.85	39.39	47.01	2	10
EN-JA	80.04	63.27	43.77	9	69.51	40.55	49.46	1.89	68
EN-IT	69.74	56.98	42.54	8	64.88	42	48.73	2.7	83
EN-ES	71.53	54.78	41.87	9	69.41	49.24	44.89	2.59	71

Empirical evaluation

- **Human evaluation:**
  - Side-by-side (with KantanLQR / ABTesting)
  - 200 sentence triples
  - Native speakers of the target language; proficient in English

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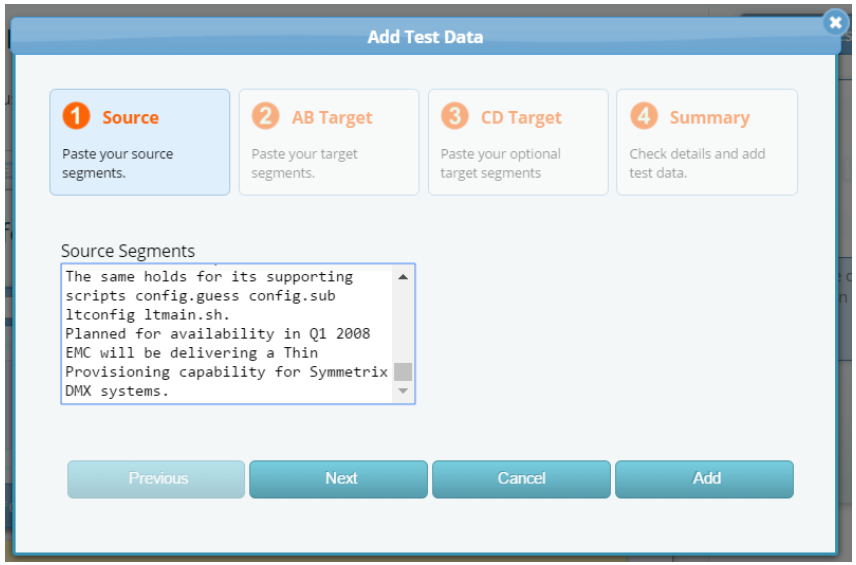

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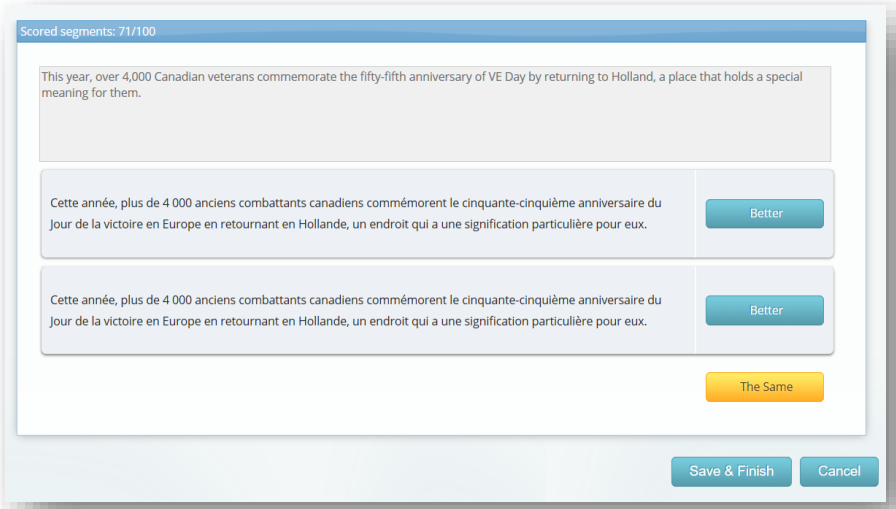

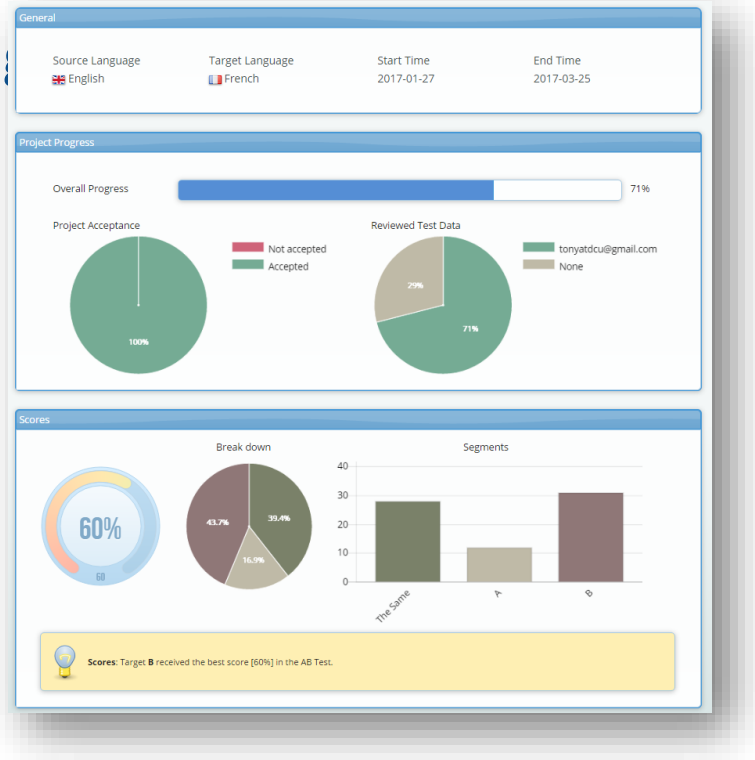

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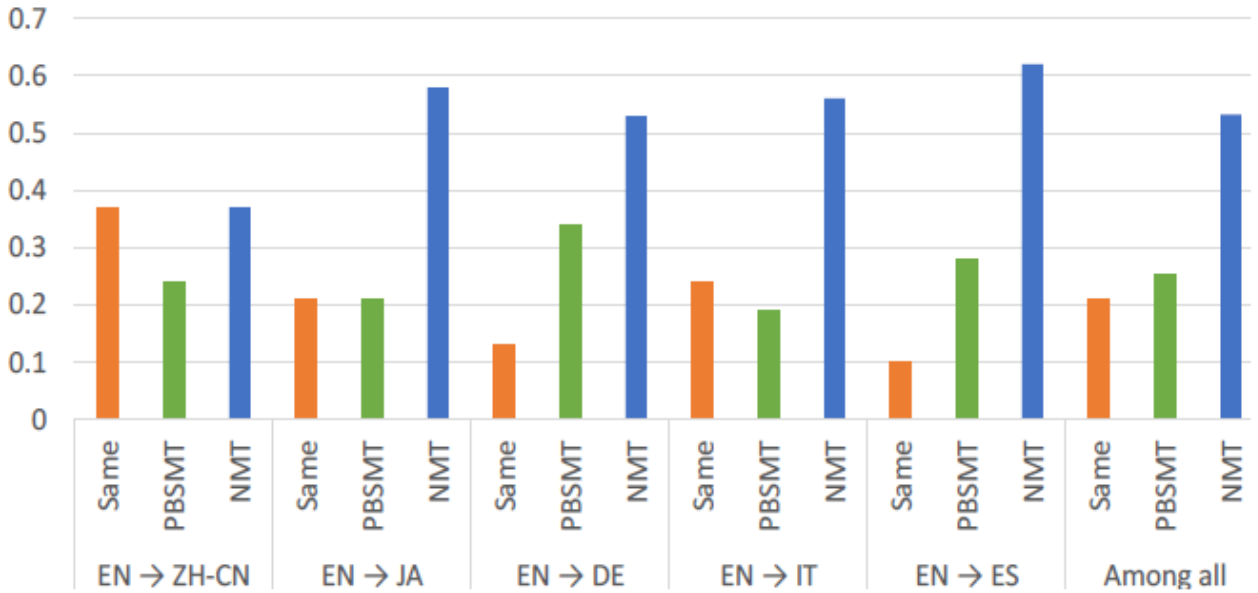

Empirical evaluation

- **BLEU analysis on the AB Test results**
  - Set of triplets for which the translation. produced by the NMT engine was considered better.
  - From this set count the translations that are scored by BLEU **lower** than their PBSMT counterparts.
  - Do the same for the PBSMT translations.

	EN-ZH-CN	EN-JP	EN-DE	EN-IT	EN-ES	Average
NMT	40%	59%	55%	34%	53%	48%
PBSMT	12%	0%	9%	9%	0%	6%

Future work

- **Perform further evaluation:**
  - Error analysis
  - Other language pairs
- **Optimise the training pipeline**
- **Improve quality evaluation**

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KantanMT.com

No Hardware. No Software. No Hassle MT.

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Thank you…