Machine Translation Summit XVI

Journey around Neural Machine Translation quality

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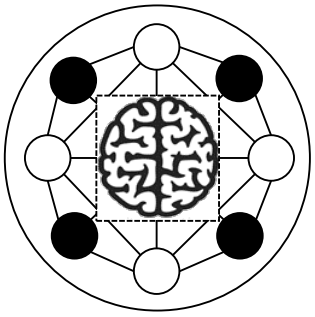
Neural Machine Translation

- **Neural Machine Translation (NMT)** is an end-to-end learning approach for automated translation, with the potential to overcome many of the weaknesses of conventional phrase-based translation systems
- The strength of NMT lies in its ability to learn directly, in an end-to-end fashion, the mapping from input text to associated output text



Ref. https://arxiv.org/abs/1609.08144

Neural Machine Translation timeline

Ref.
(1) https://research.googleblog.com/2016/09/a-neural-network-for-machine.html
(2) https://blogs.msdn.microsoft.com/translation/2016/11/15/microsoft-translator-launching-neural-network-based-translations-for-all-its-speech-languages/

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Neural Machine Translation timeline

"**Google** Neural Machine Translation (GNMT), an end-to-end learning framework that learns from millions of examples, and provided significant improvements in translation quality. It was enabled for eight languages: to and from English and French, German, Spanish, Portuguese, Chinese, Japanese, Korean and Turkish" *(1)*

Ref.
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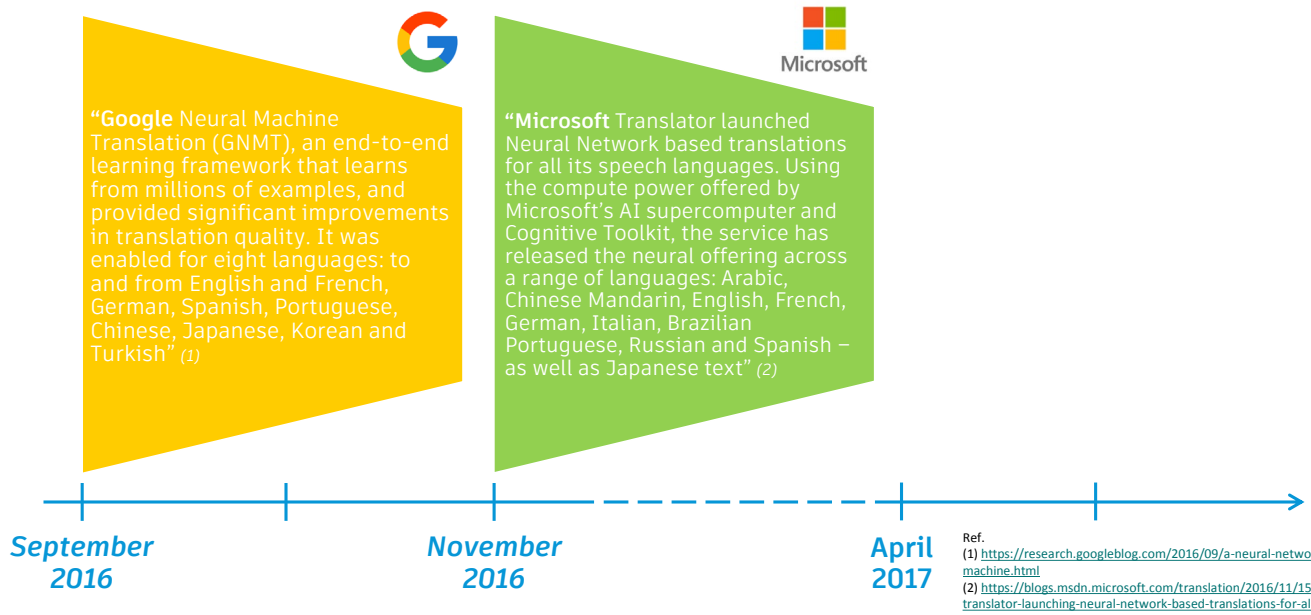
Neural Machine Translation timeline



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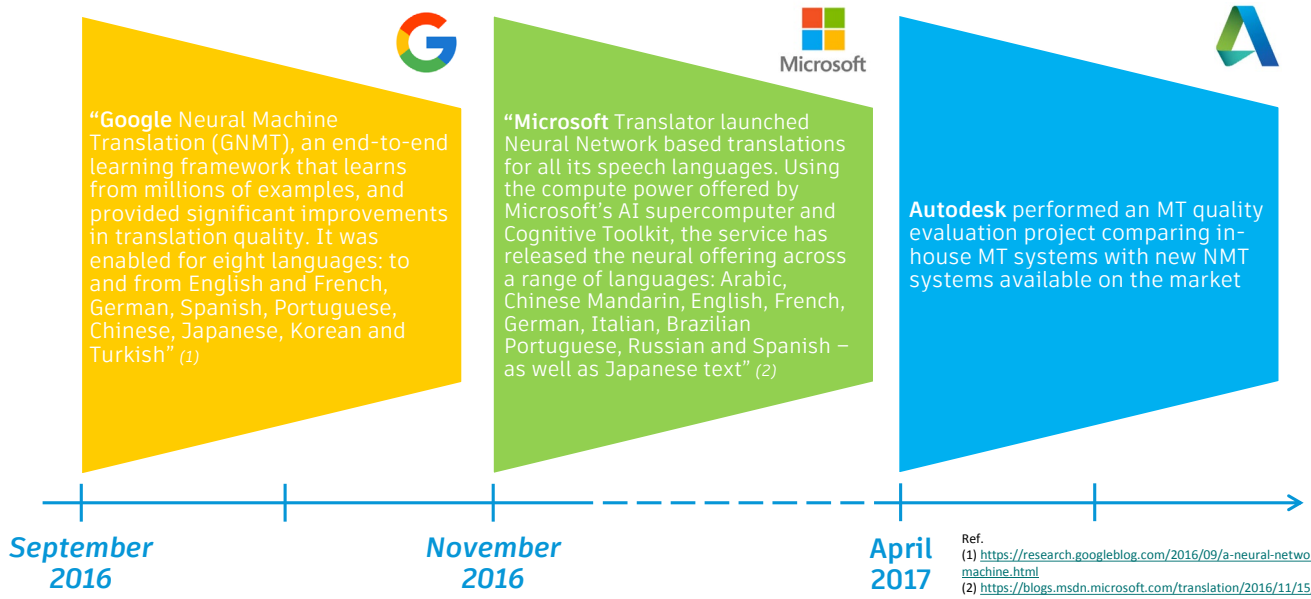
Neural Machine Translation timeline



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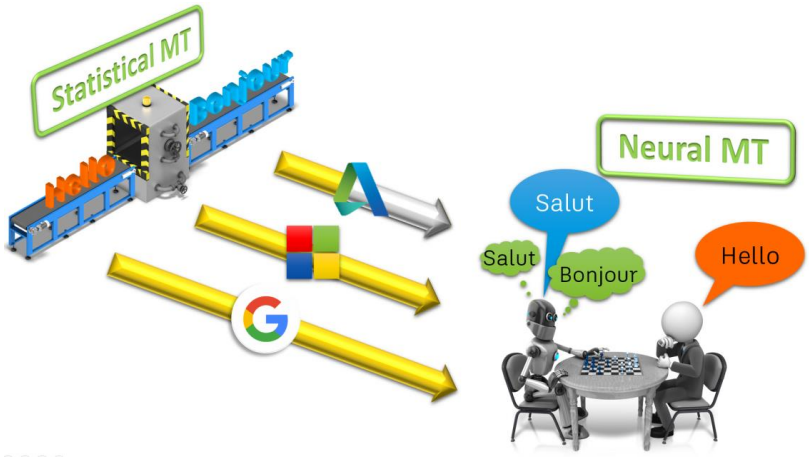
Goal



Assess quality of *Neural MT* versus *Autodesk MT*

Assumptions: MT systems

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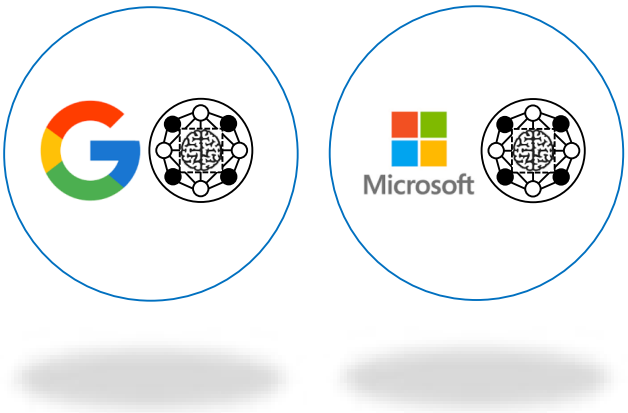

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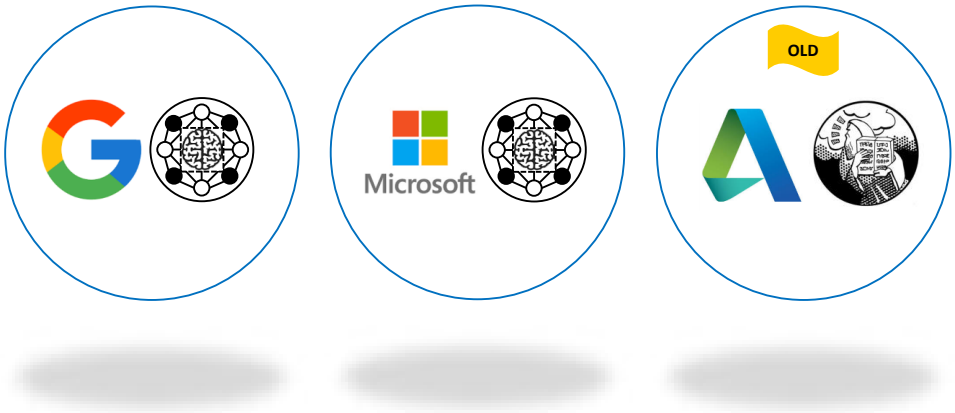

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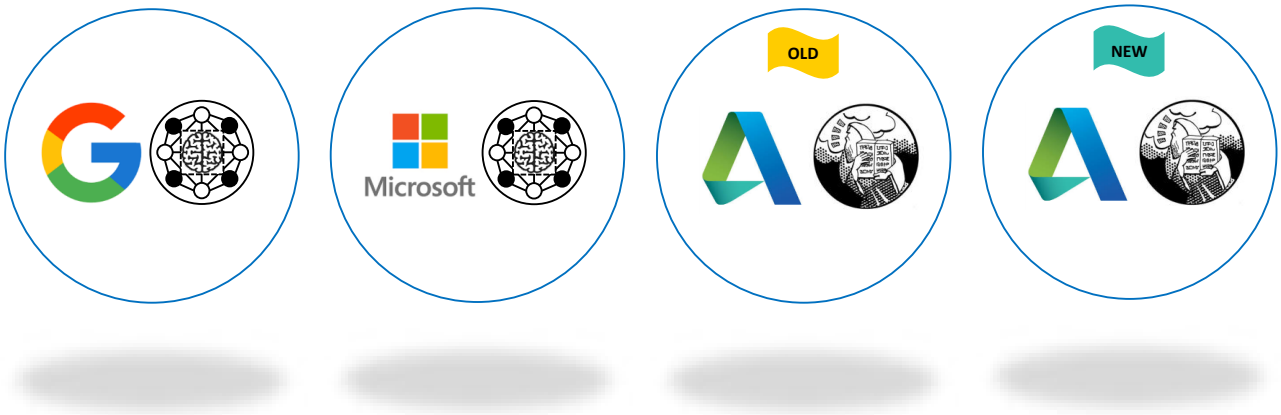

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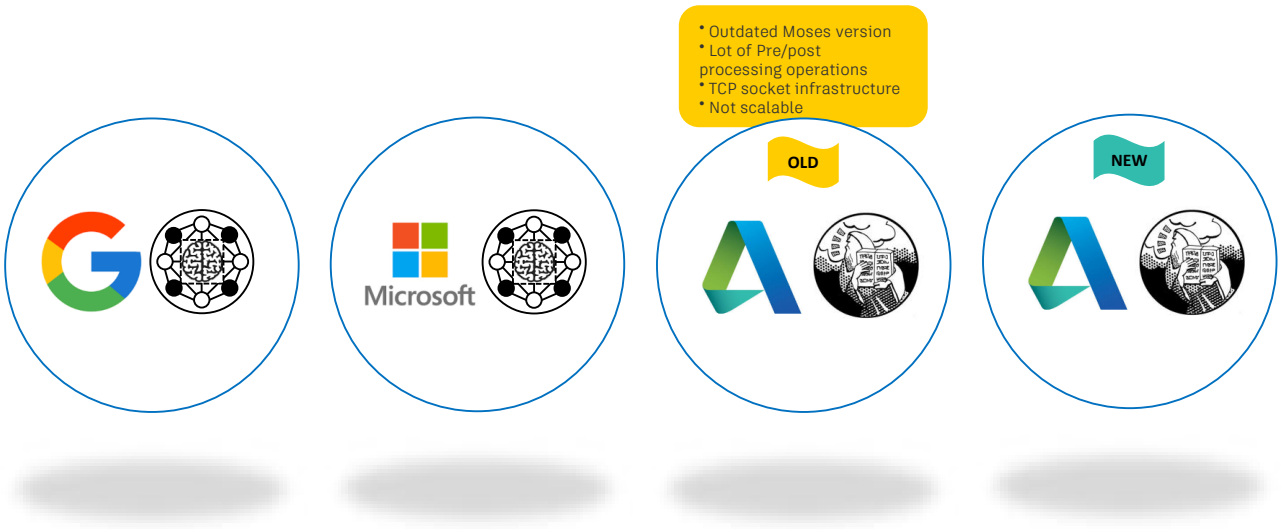

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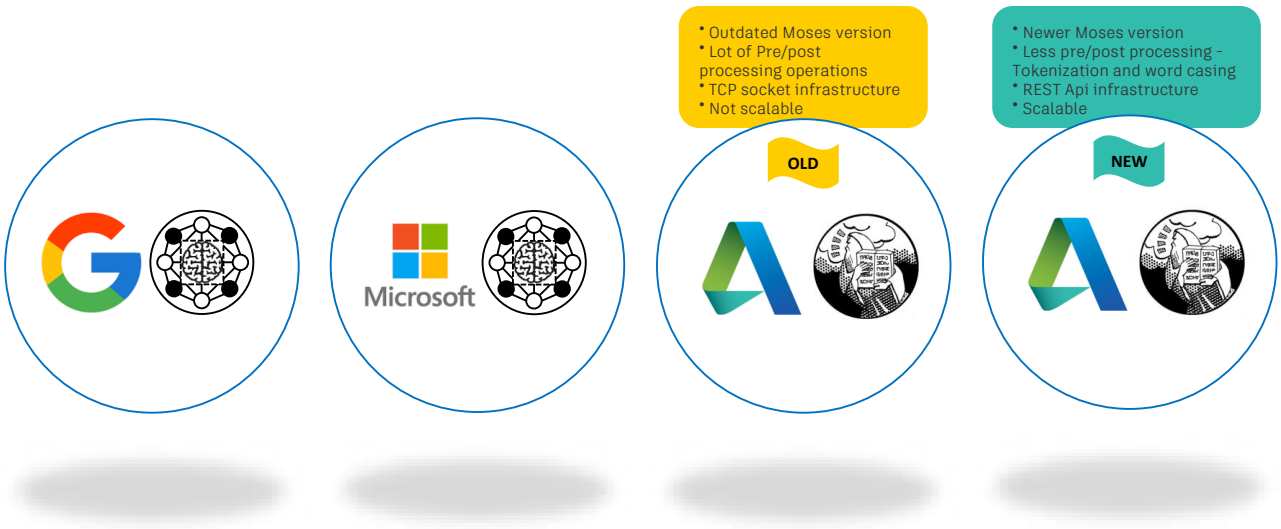

Assumptions: Products

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ADSK legacy product

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Assumptions: Products

ADSK legacy product

ADSK new product or External product

Assumptions: ADSK legacy product

- Human Translation for these products started from the **OLD ADSK MT** (translation is now post-editing)
- For some portions of *Infraworks* and *Dynamo* final Human Translation was then used to retrain the engines **ADSK MT, OLD** and **NEW**
- The nature of Autodesk content favors higher matches even on non-trained engines (i.e. Architecture, 3D and so on)
- For these products it looks like there isn't much difference whether an engine was retrained or not, therefore we will not make a distinction in the conclusions

Assumptions: Products

- Cases which shouldn't give any advantage to **ADSK MTs**
- It was not easy to find content for which we haven't trained our engines. But looking at the results it is clear that we would benefit from more languages at least for the identified content.

  For example we don't have such samples for ***German*** and ***Simplified Chinese***.

Assumptions: Scope

		Languages					
PRODUCT	CATEGORY	German	French	Spanish	Japanese	Simplified Chinese	Portuguese Brazilian
Dynamo	SW	45k	45k	45k	12k	45k	
	DOC	51k	51k	51k	12k	51k	
AUTODESK INFRAWORKS	SW	45k	57k	56k	18k	17k	55k
	DOC	374k	437k	286k	89k	119k	427k
Knowledge Network	DOC	166k	164k	151k	50k	43k	
AUTODESK MIX	DOC	5k	6k	7k	2k	1.5k	6k
Delcam	DOC		244k		57k		658k
Apache OpenOffice	DOC		397k	282k	407k		

ADSK legacy product

ADSK new product or External product

Used to train ADSK MT

Approach

Approach

AUTOMATIC

- Automatic quality evaluation comparing machine's output and human translation

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Approach

AUTOMATIC

- Automatic quality evaluation comparing machine's output and human translation

MANUAL

- Human review, involving internal native speakers and external reviewers

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Automatic: mt-eval system

Ref. *
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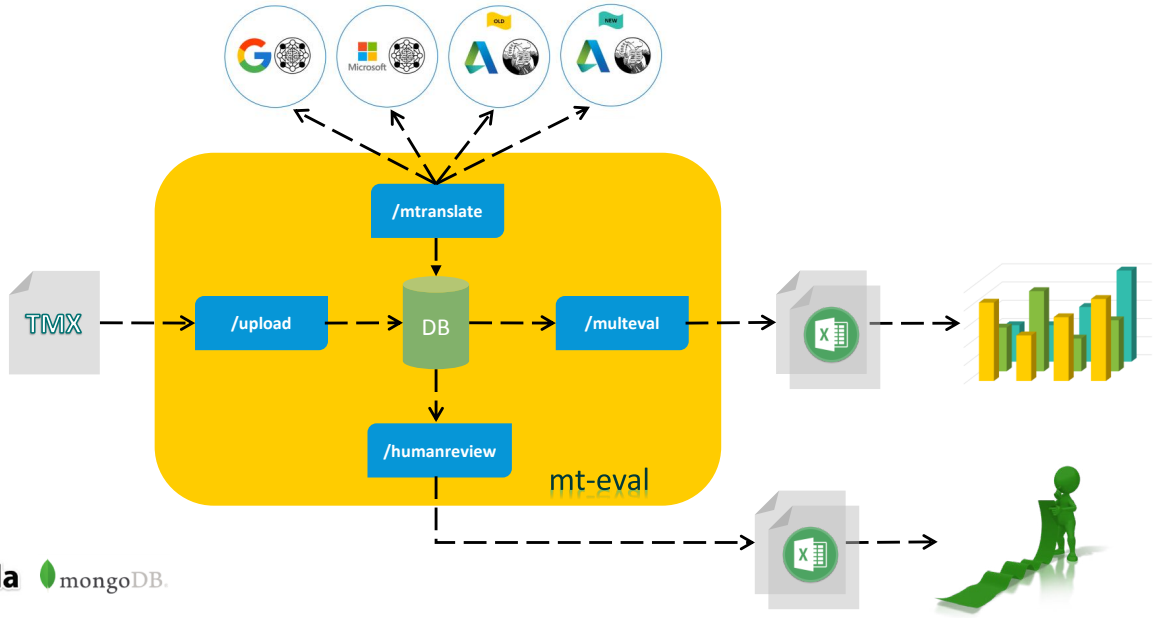
https://github.com/jhclark/multeval



Scala mongoDB.

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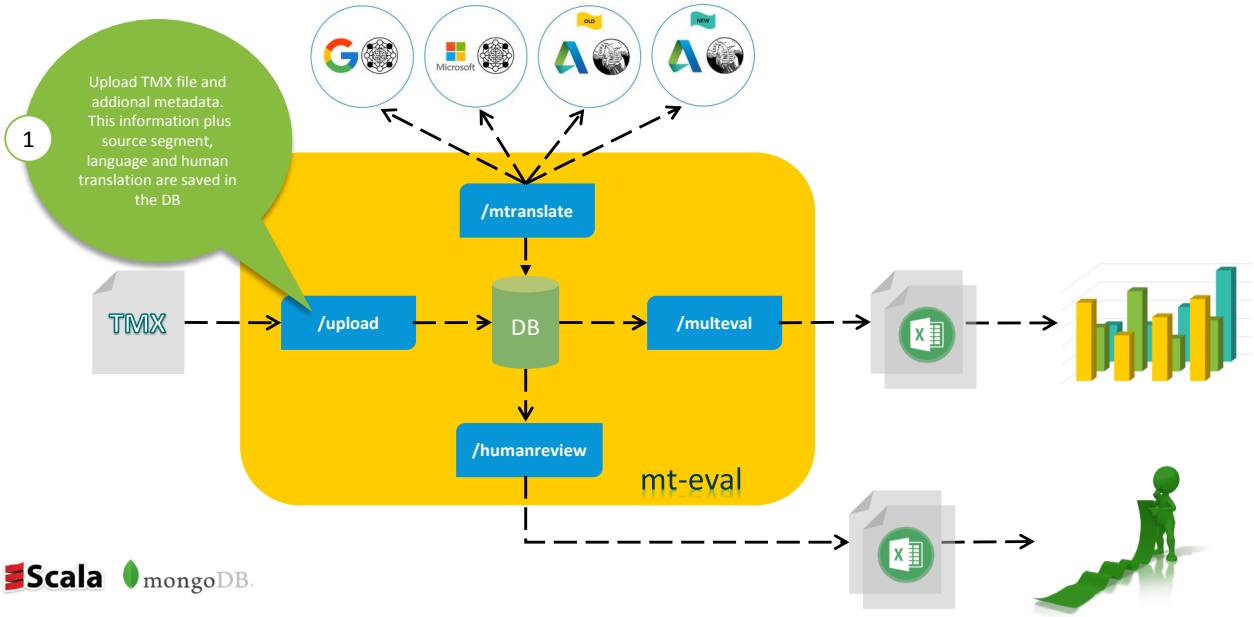

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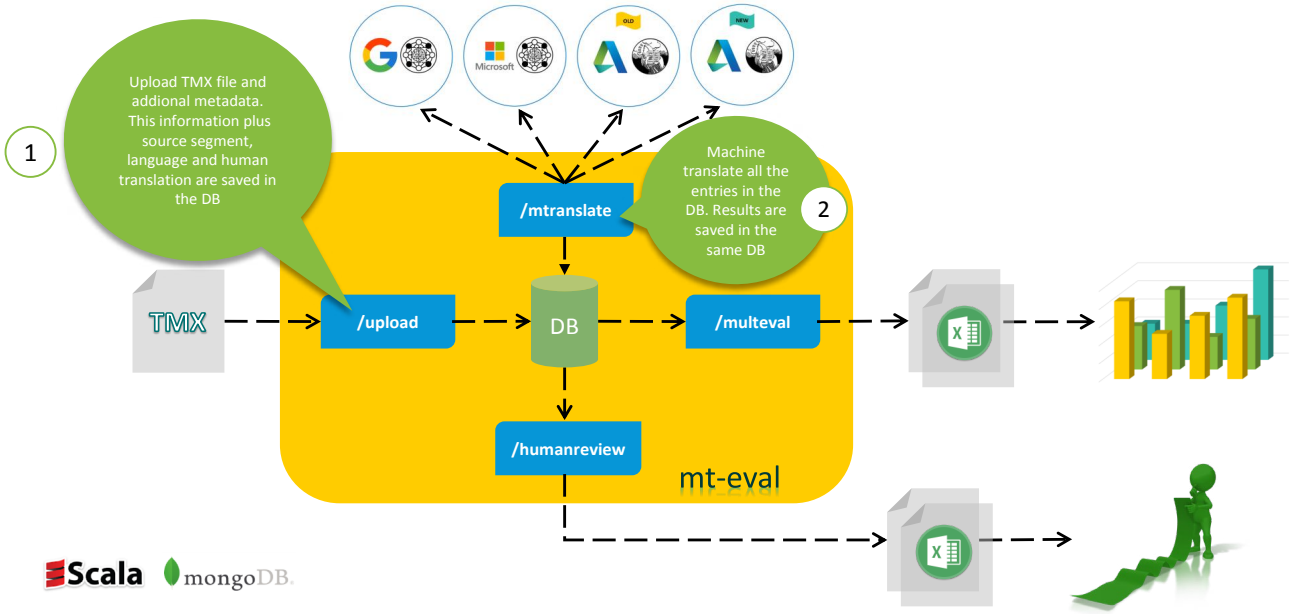

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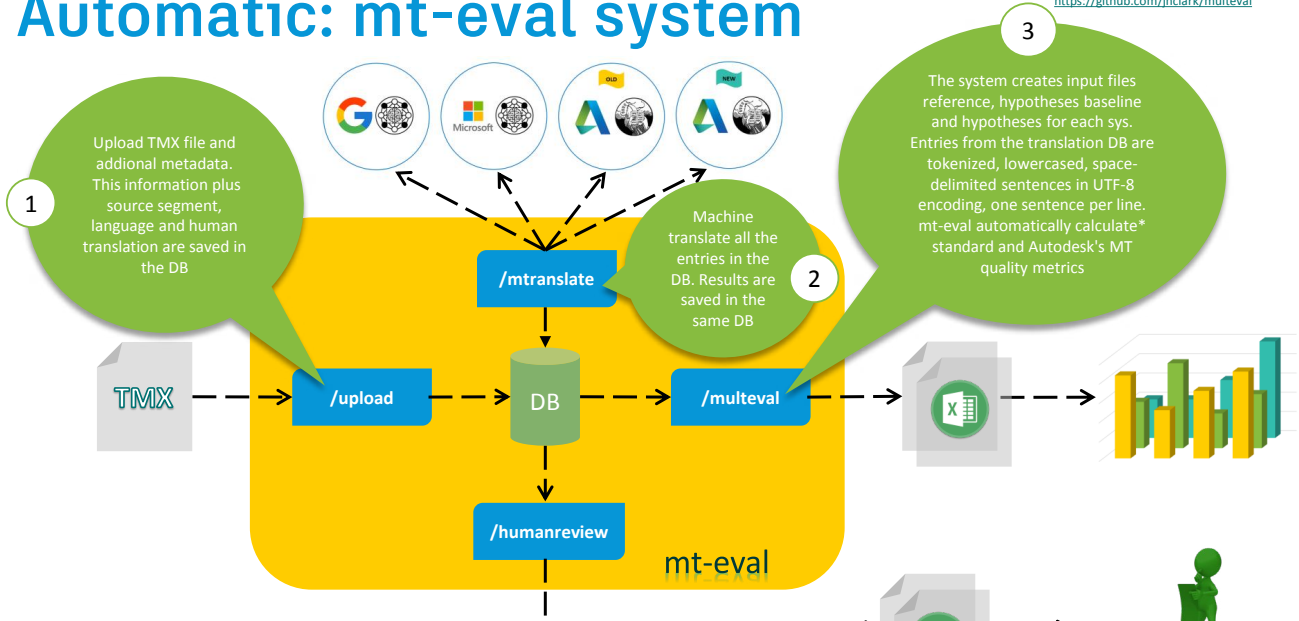

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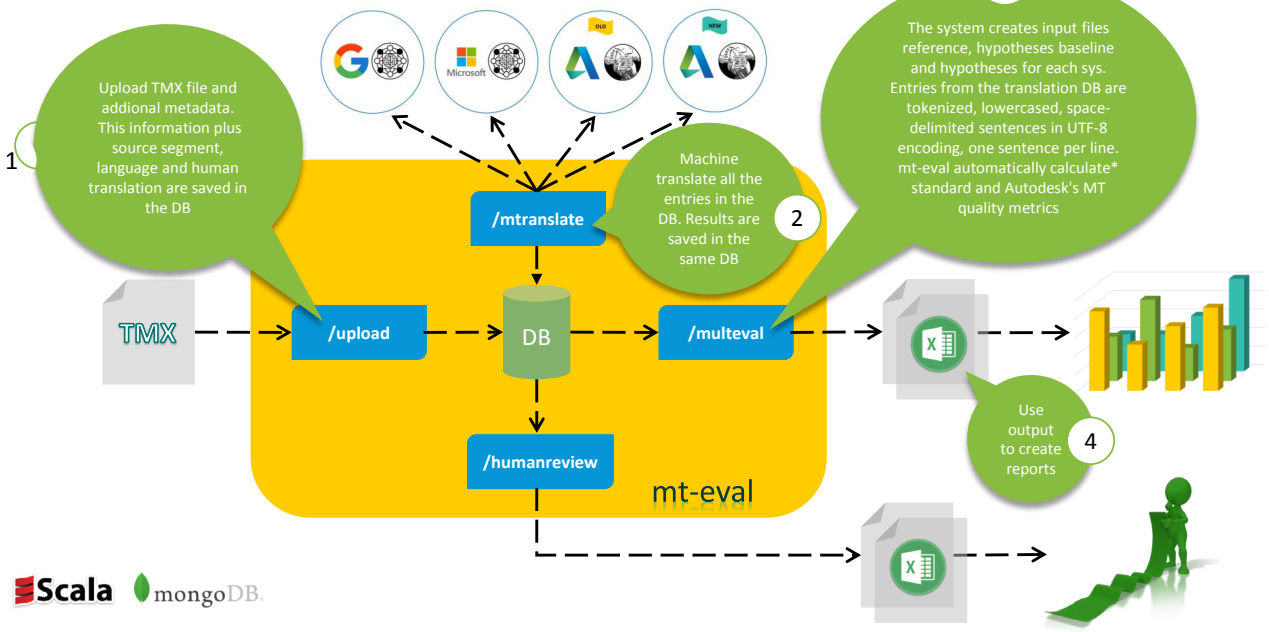

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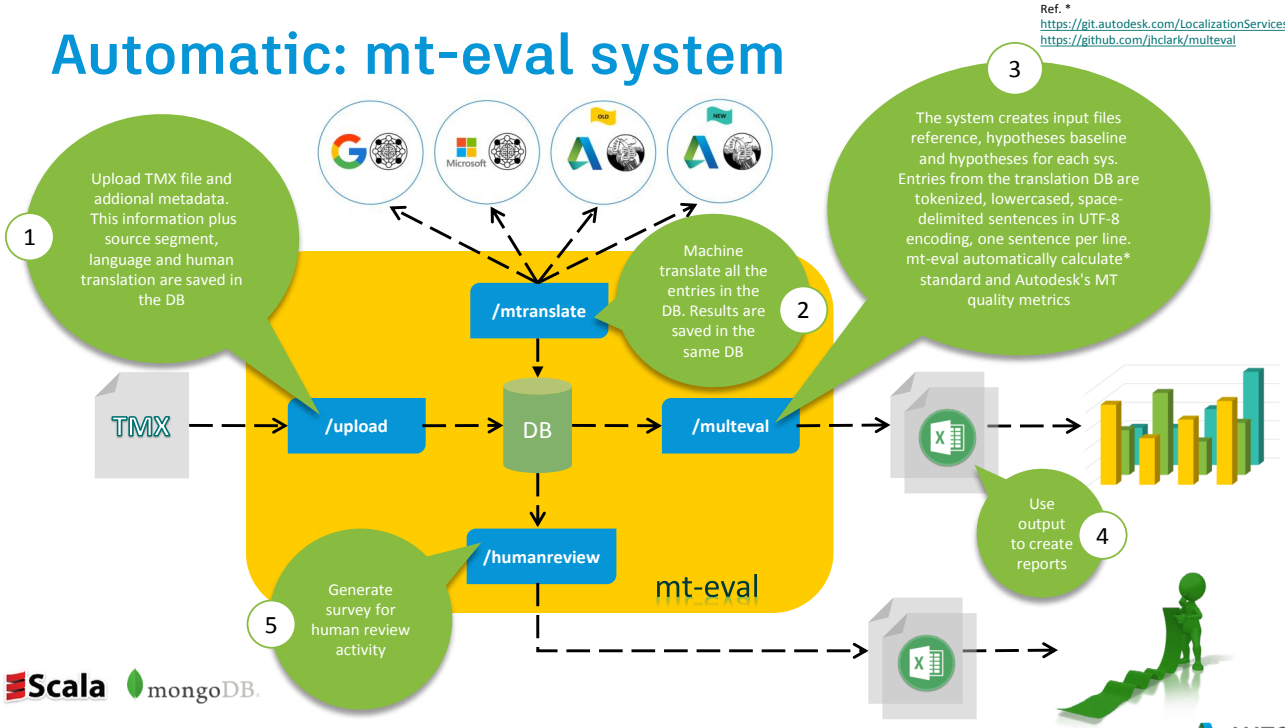

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Automatic: MT quality metrics

COMMON

BLEU - BilinguaL Evaluation Understudy

- Quality is considered to be the correspondence between a machine's output and that of a human. The closer a machine translation is to a professional human translation, the better it is (1)

METEOR - Metric for Evaluation of Translation with Explicit Ordering

- The metric evaluates translation hypotheses by aligning them to reference translations and calculating sentence-level similarity scores. It uses stemming and synonymy matching, along with the standard exact word matching. The metric was designed to fix some of the problems found in BLEU (2)

TER - Translation Error Rate

- A method to determine the amount of Post-Editing required for machine translation jobs. The automatic metric measures the number of actions required to edit a translated segment inline with one of the reference translations (3)

Length

- Machine's output length over professional human translation length as a percent. If it is 100%, machine and human translation output have the same length (4)

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CFS - Character-based Levenshtein distance

- Levenshtein distance on character level

WFS - Word-based Fuzzy Score

- Levenshtein distance on word level

JFS - Joint Fuzzy Score

- It is a combination of the two above, taking the worse of the two scores for each segment and computing a joined score like this for the whole test set

All three below are based on the ***Levenshtein*** distance between the output and the reference translation, the higher the score the better.

Levenshtein distance between two words is the minimum number of single-character edits (i.e. insertions, deletions or substitutions) required to change one word into the other.

Ref.
(1) https://en.wikipedia.org/wiki/BLEU
(2) http://www.cs.cmu.edu/~alavie/METEOR/
(3) https://kantanmtblog.com/2015/07/28/what-is-translation-error-rate-ter/
(4) https://git.autodesk.com/LocalizationServices/multeval

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Manual: Human review rating

Adequacy

How much of the meaning expressed in the source is also expressed in the target translation

- **None:** Completely nonsense translation
- **Little:** Sentence preserves some of the meaning of the source sentence but misses significant parts
- **Most:** Sentence retains most of the meaning of the source sentence, but may have some grammar mistakes
- **Everything:** Perfect translation: the meaning of the translation is completely consistent with the source, and the grammar is correct

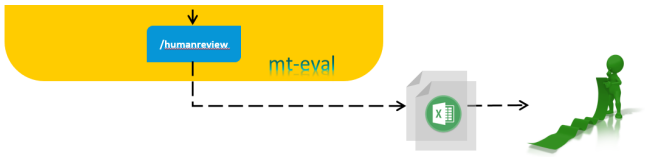
Fluency

Readability and naturalness of the translated text

- **Incomprehensible:** The content is not fluent nor natural in the target language. The translated text is a word by word translation, therefore it is hard to read and understand.
- **Disfluent:** The content reads like it was translated. Some sentence structures don't seem to be natural in the target language or are not idiomatic. It contains some literal translations.
- **Good:** The content reads like it was originally written in the target language. It uses proper sentence structure and idiomatic expressions. But a few minor improvements might be necessary.
- **Flawless:** The content reads like it was originally written in the target language. It uses proper sentence structure and idiomatic expressions.

*OLD ADSK not rated
AUTODESK.

Manual: Survey



Accuracy Score	Fluency Score	Translation	Source
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4	4	条件より大きな値を表示します。	Shows values greater than the condition.
4	4	実習プログラムの一環としてオートデスクの教育機関限定ライセンスの対象ソフトウェアの使用が商用プロジェクトになる場合: オートデスクの教育機関限定ライセンスの使用条件により、その使用は教育と実習関連活動に限定されます。	If your use of Autodesk software subject to an Educational license as part of the apprentice program will be part of commercial projects: The terms and conditions for Autodesk Educational licenses restrict the use exclusively to teaching and exercising activities.
4	4	P&IDとの互換性	P&ID compatibility
1	1	長細いフィーチャが最適でない可能性が高いというこの方法でフライス加工します。	Long thin features probably are not best milled in this way.
4	4	{1}ベクトルの詳細]{2}	{1}Vector Details{2}
4	4	{1} 境界カーブ {2} の下で {3} 境界 {4} をクリックします。	Under {1}Boundary curves{2}, click {3}Boundaries{4}.
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4	4	改訂日	Revision Date
4	4	579H1	579H1
4	4	並び替え：	Sort by:
1	3	ジオメトリ。平面	Geometry.Plane
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Internal ~250 segments | **External** ~ 2500 segments

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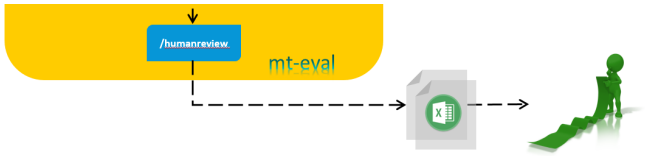

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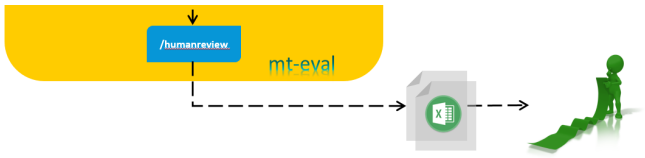

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AUTODESK.

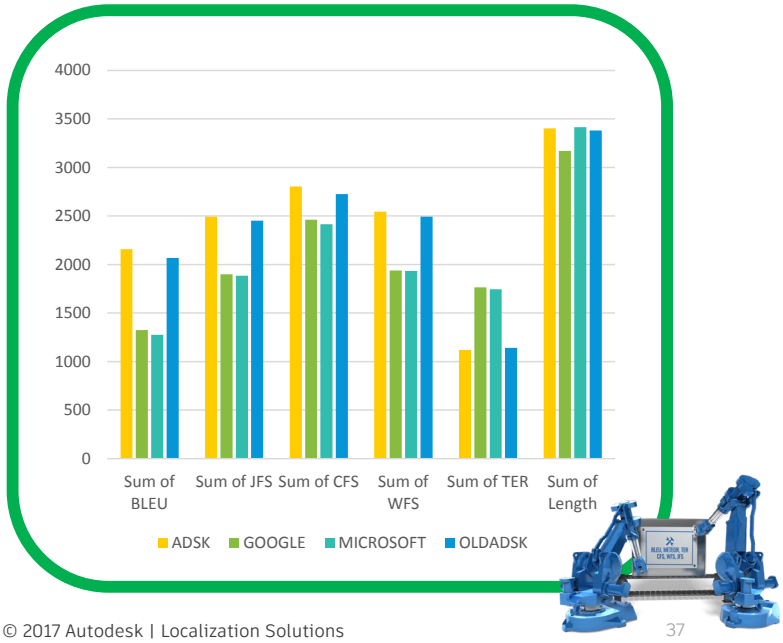
Results: Automatic

* METEOR only for FR and DE – not in the graph

AUTODESK.

Results: Automatic

ADSK legacy product



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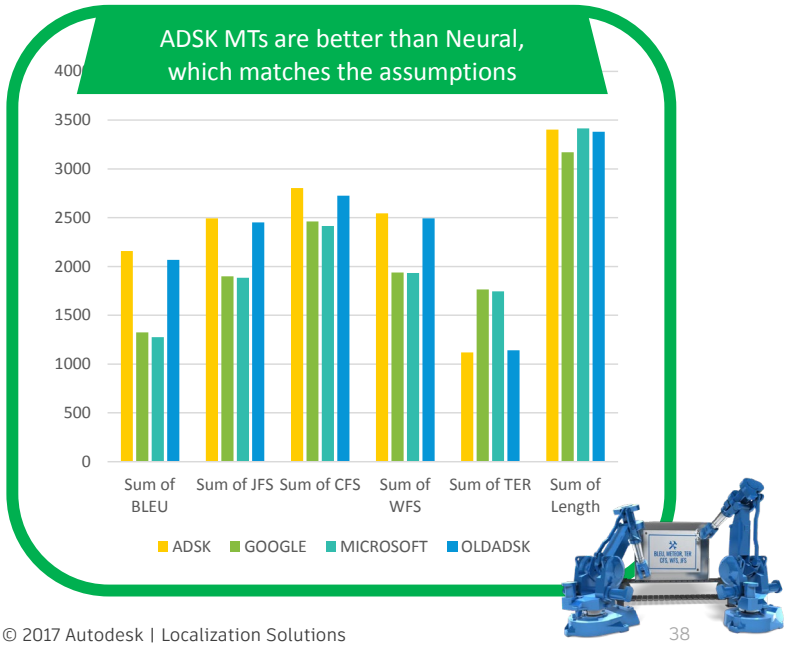
Results: Automatic

ADSK legacy product

ADSK MTs are better than Neural, which matches the assumptions



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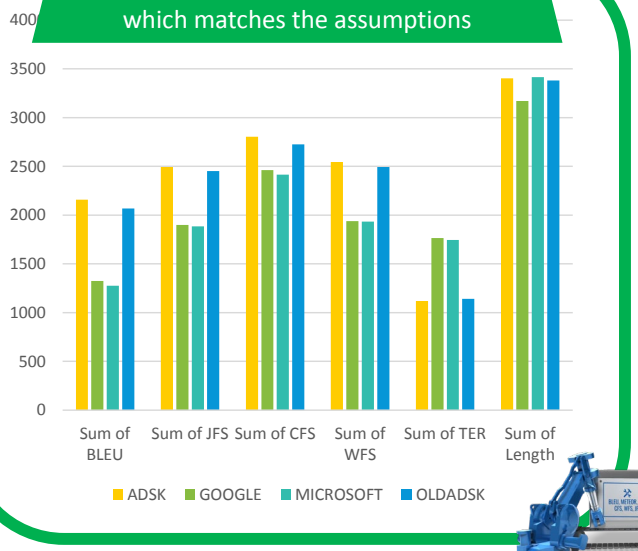
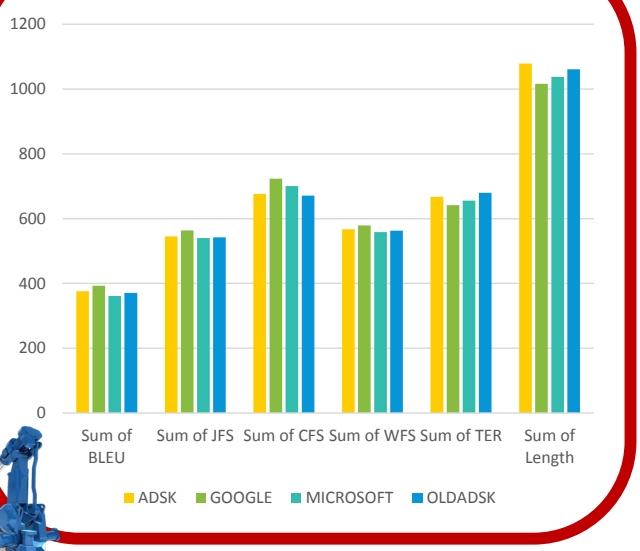


ADSK new product or External product



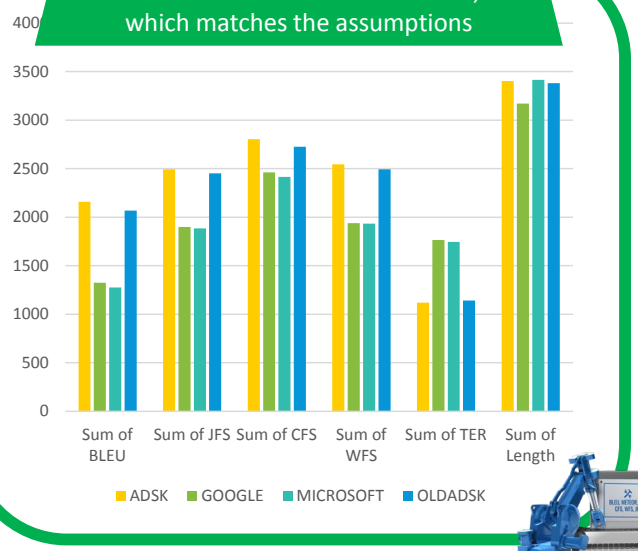
* METEOR only for FR and DE – not in the graph

AUTODESK.

Results: Automatic

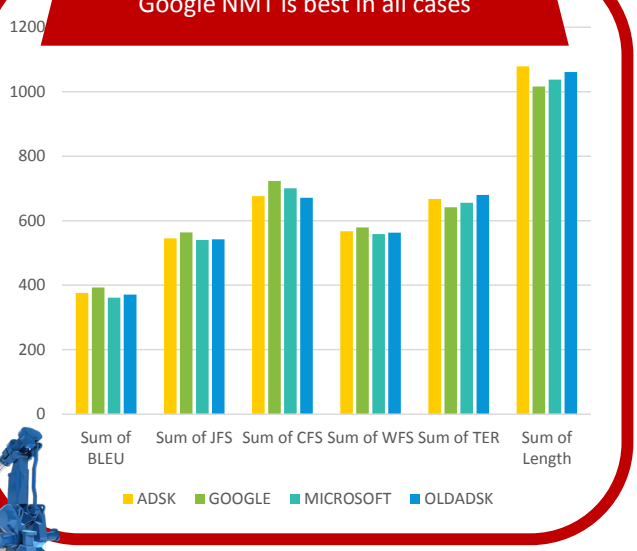
ADSK legacy product

ADSK MTs are better than Neural, which matches the assumptions



ADSK new product or External product

Google NMT is best in all cases



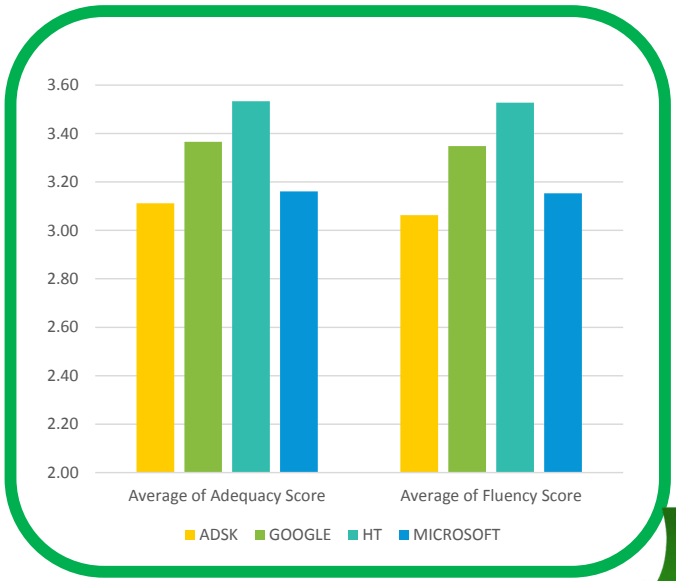
* METEOR only for FR and DE – not in the graph

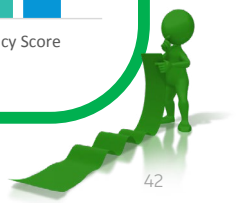
AUTODESK.

Results: Manual

Results: Manual

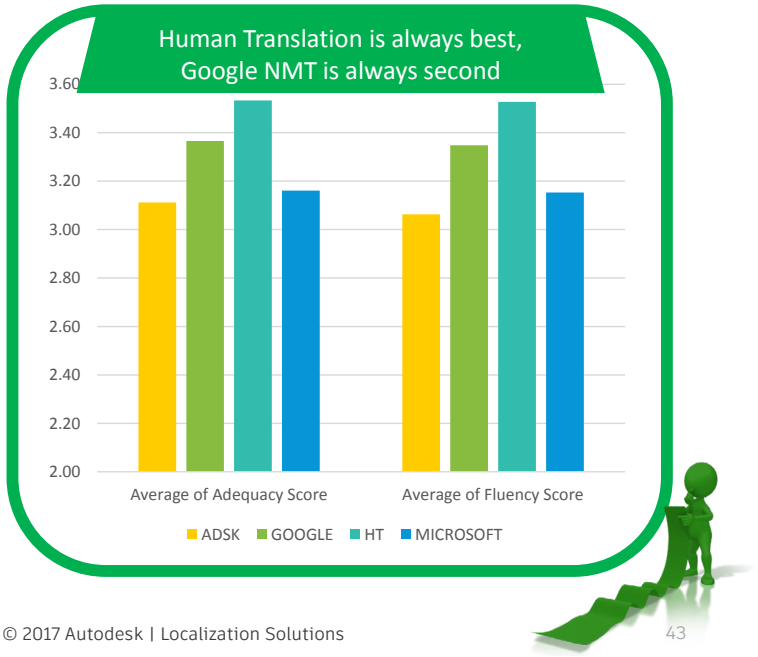
ADSK legacy product





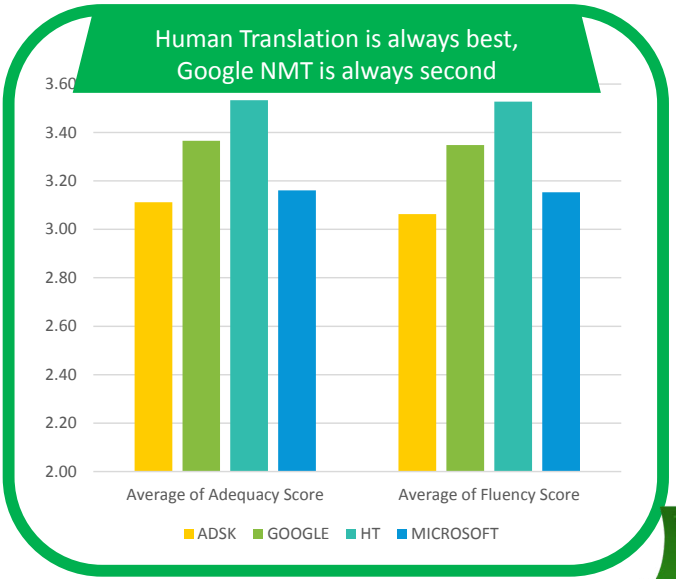
Results: Manual

ADSK legacy product

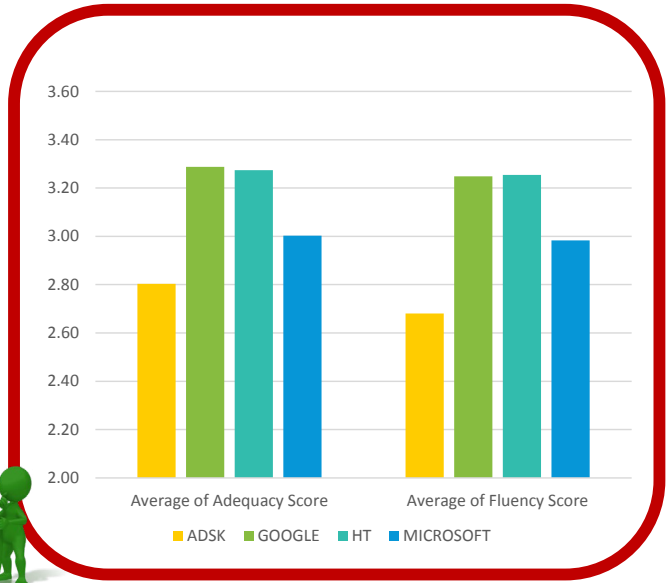


Results: Manual

ADSK legacy product



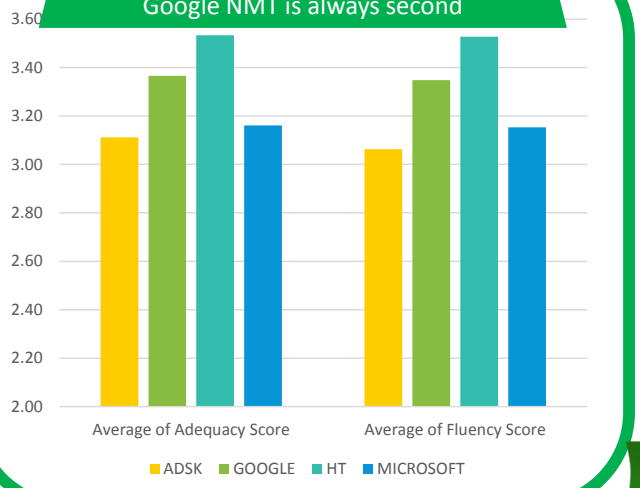
ADSK new product or External product



Results: Manual

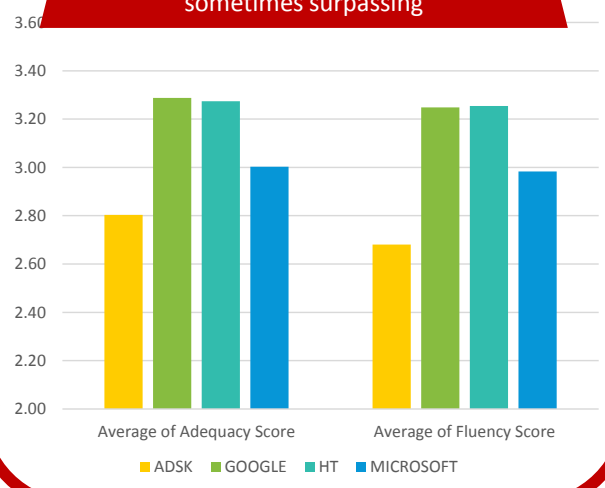
ADSK legacy product

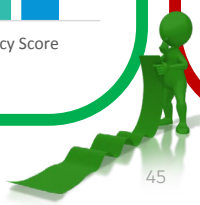
Human Translation is always best, Google NMT is always second



ADSK new product or External product

Google NMT is very close to Human, sometimes surpassing





Conclusions

- Commercial Neural MT are **viable**
- **Moses Engines** are still useful on legacy products
- Next Steps:
  - Explore **Open source solutions** (i.e. OpenNMT)
  - Use the best **MT system** that matches current context (i.e. product, language, content type, etc.)

Result: Breakdown

Approach		Results
ADSK legacy product	**AUTOMATIC**	•NEW and OLD ADSK MTs are clearly better than Neural - which matches the assumptions •NEW and OLD ADSK MTs tend to have very similar results, except for ***German*** •Between Neural MTs, only ***Japanese*** shows better results with Microsoft than Google
	MANUAL	•Human Translation is always best except one case only for fluency for ***Portuguese*** where Google Neural is a little bit better •Google Neural is always second •Hard to say whether ADSK or Microsoft are best, it varies between languages but globally they are quite a bit lower than the others and close together
ADSK new product or External product [Breakdown]	**AUTOMATIC**	•Google Neural tends is best in all cases except ***Japanese*** •For ***Japanese*** Microsoft Neural is the best •Neural is better than ADSK MT, NEW and OLD
	MANUAL	•Google Neural is very close to Human, sometimes surpassing •Microsoft and ADSK are often close alternating third position *For OPENOFFICE we had to ignore Human Translation scores*

Breakdown: ADSK legacy product (1/2)

Language	Approach	Ranking	Notes
German	**AUTOMATIC**	1.NEW ADSK 2.OLD ADSK 3.Google Neural / Microsoft Neural	•NEW ADSK is the best and quite a bit better than the OLD ADSK •Google Neural and Microsoft Neural have very similar results, which are quite a bit lower than ADSK
	MANUAL	1.Human Translation 2.Google Neural 3.Microsoft Neural 4.NEW ADSK	•Human is best •Second Google Neural, not too much lower •Third is Microsoft Neural •Worst is NEW ADSK •*Adequacy* and *Fluency* same pattern for all
Spanish	**AUTOMATIC**	1.NEW ADSK / OLD ADSK 2.Google Neural 3.Microsoft Neural	•NEW and OLD ADSK are the best and very close •Google Neural is better than Microsoft Neural, but quite a bit lower than ADSK
	MANUAL	1.Human Translation 2.Google Neural 3.NEW ADSK / Microsoft Neural	•Human is best •Second Google Neural, then NEW ADSK then Microsoft Neural > these three are very close •*Adequacy* and *Fluency* same pattern for all
French	**AUTOMATIC**	1.NEW ADSK / OLD ADSK 2.Google Neural 3.Microsoft Neural	•NEW and OLD ADSK are the best and very close •Google Neural is better than Microsoft Neural, but quite a bit lower than ADSK
	MANUAL	1.Human Translation 2.Google Neural 3.NEW ADSK / Microsoft Neural	•Human is best •Second Google Neural •Then ADSK and then MS > these two are very close •*Adequacy* and *Fluency* same pattern for all

Breakdown: ADSK legacy product (2/2)

Language	Approach	Ranking	Notes
Portuguese	**AUTOMATIC**	1.NEW ADSK / OLD ADSK 2.Google Neural 3.Microsoft Neural	•NEW and OLD ADSK are the best and very close •Google Neural is better than Microsoft Neural, but quite a bit lower than ADSK
	MANUAL	*Adequacy* 1.Human Translation 2.Google Neural 3.NEW ADSK / Microsoft Neural *Fluency* 1.Google Neural 2.Human Translation 3.NEW ADSK / Microsoft Neural	•*Adequacy* • Human is best, Goggle Neural second quite a bit lower •*Fluency* • Google Neural is best, Human is close •NEW ADSK and Microsoft Neural are quite a bit lower and close for both Adequacy and FL
Japanese	**AUTOMATIC**	1.NEW ADSK / OLD ADSK 2.Google Neural 3.Microsoft Neural	•NEW and OLD ADSK MT are the best and very close •Microsoft Neural is better than Google Neural, but lower than ADSK •One score, CFS > all results are incredibly close
	MANUAL	1.Human Translation 2.Google Neural 3.Microsoft Neural 4.NEW ADSK	•Human is best •Second Google Neural, not too much lower •Third is Microsoft Neural •Worst is NEW ADSK •*Adequacy* and *Fluency* same pattern for all
Simplified Chinese	**AUTOMATIC**	1.NEW ADSK / OLD ADSK 2.Google Neural 3.Microsoft Neural	•NEW and OLD ADSK MT are the best and very close •Google Neural is quite a bit better than Microsoft Neural, but quite a bit lower than NEW ADSK
	MANUAL	*Adequacy* 1.Human Translation 2.Google Neural 3.NEW ADSK 4.Microsoft Neural *Fluency* 1.Human Translation 2.Google Neural 3.Microsoft Neural 4.NEW ADSK	•Human is best - both Adequacy and Fl •Google Neural is second best - both Adequacy and Fl •*Adequacy* • NEW ADSK is better than Microsoft Neural •*Fluency* • Microsoft Neural is slightly better than ADSK MT

ADSK legacy product: Trained VS Not-Trained

Approach	TRAINED: DYNAMO (SW), INFRAWORKS (SW/DOC) [Breakdown]	NOT-TRAINED: DYNAMO (DOC), AKN (DOC), ADSK MIX (DOC) [Breakdown]
MANUAL	•Human Translation is always best •Google Neural is second in most of the languages •NEW ADSK is close to or a litte bit better than Google Neural in ***French***, ***Spanish*** and ***Portuguese*** •Microsoft Neural is worst in most of the languages except ***Japanese*** and ***German*** *Fluency*	•Human Translation is always best except ***Portuguese*** where Google Neural is best •Google Neural is second and close to Human Translation in most of the languages •Microsoft Neural is third in most of the languages except ***Spanish*** •NEW ADSK is worst not far away from Microsoft Neural
AUTOMATIC	•NEW ADSK is always best •OLD ADSK is always second except ***Japanese*** •Google Neural and Microsoft Neural are close in most of the languages except • ***Simplified Chinese*** where Google is clearly better than Microsoft Neural • ***Japanese*** where Microsoft Neural is clearly better than Google Neural	•OLD ADSK is always best •NEW ADSK is always second excpept CFS in ***Japanese*** and ***Simplified Chinese*** •Google Neural is third •Microsoft Neural is fourth, very close to Google Neural in most of the languages

Breakdown: ADSK new product or External product (1/2)

Product	Language	Approach	Ranking	Notes
DELCAM	***French***	**AUTOMATIC**	1.Google Neural / Microsoft Neural 2.NEW ADSK 3.OLD ADSK	•Google Neural and Microsoft Neural are the best and very close •NEW ADSK is a bit lower than Neural, and quite a bit better than OLD ADSK
		MANUAL	1.Human Translation 2.Google Neural 3.Microsoft Neural 4.NEW ADSK	•Human is best •Google is second not too far from Human •Microsoft Neural is third quite a bit lower •NEW ADSK last not too far from Microsoft Neural
	Japanese	**AUTOMATIC**	1.Microsoft Neural 2.Google Neural 3.NEW ADSK / OLD ADSK	•Microsoft Neural is the best and quite a bit better than Google Neural •NEW and OLD ADSK are lower and very close
		MANUAL	1.Google Neural 2.Human Translation / Microsoft Neural 3.NEW ADSK	•Google Neural is best •Followed by Human and Microsoft Neural being very close together •NEW ADSK last a bit lower
	Portuguese	**AUTOMATIC**	1.Google Neural 2.Microsoft Neural 3.NEW ADSK / OLD ADSK	•Google Neural is the best •Google and MS Neural are the best and close •NEW and OLD ADSK are lower and very close
		MANUAL	*Adequacy* 1.Human Translation 2.Google Neural 3.Microsoft Neural 4.NEW ADSK *Fluency* 1.Google Neural 2.Human Translation 3.Microsoft Neural 4.NEW ADSK	•*Adequacy* • Human is best, Google Neural second but very close •*Fluency* • Opposite, Google Neural best with Human very close •Third is Microsoft Neural followed closely by NEW ADSK

Breakdown: ADSK new product or External product (2/2)

Product	Language	Approach	Ranking	Notes
OPENOFFICE	***French***	**AUTOMATIC**	1.Google Neural 2.Microsoft Neural 3.NEW ADSK 4.OLD ADSK	•Google Neural is the best •Google Neural and Microsoft Neural are the best and close •NEW and OLD ADSK are lower and close
		MANUAL	1.Google Neural 2.Microsoft Neural 3.NEW ADSK	•Google Neural is best •Microsoft Neural is second •NEW ADSK last not too far
	Japanese	**AUTOMATIC**	1.Microsoft Neural (except BLEU) 2.OLD ADSK 3.Google Neural 4.NEW ADSK	•Microsoft Neural is the best except for BLEU where OLD ADSK wins •OLD ADSK is generally higher than Google Neural
		MANUAL	1.Google Neural / Microsoft Neural 2.NEW ADSK	•Google Neural and Microsoft Neural are best very close •*Adequacy* • Microsoft Neural a little better, opposite for *Fluency* •NEW ADSK is quite a bit lower
	Spanish	**AUTOMATIC**	1.Google Neural 2.OLD ADSK / NEW ADSK / Microsoft Neural	•Google Neural is the best •The rest is lower and quite similar results
		MANUAL	1.Google Neural 2.NEW ADSK 3.Microsoft Neural	•Google Neural is best •NEW ADSK is second •Microsoft Neural is last •All very close

AUTODESK.