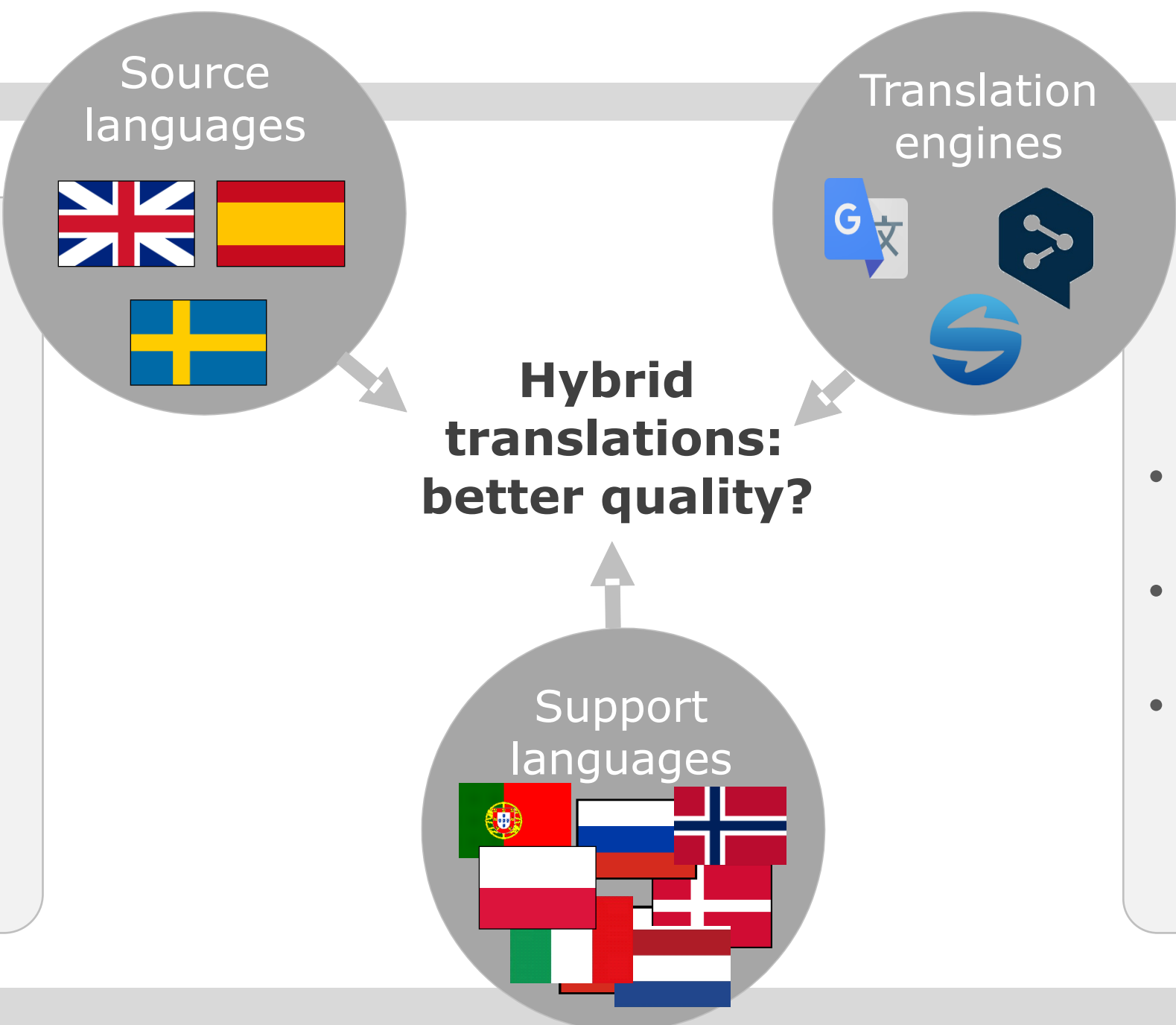


Multiple Translation Paths for SNOMED CT Localisation

Clinical terminology standards require adaptation to clinicians' language to be usable

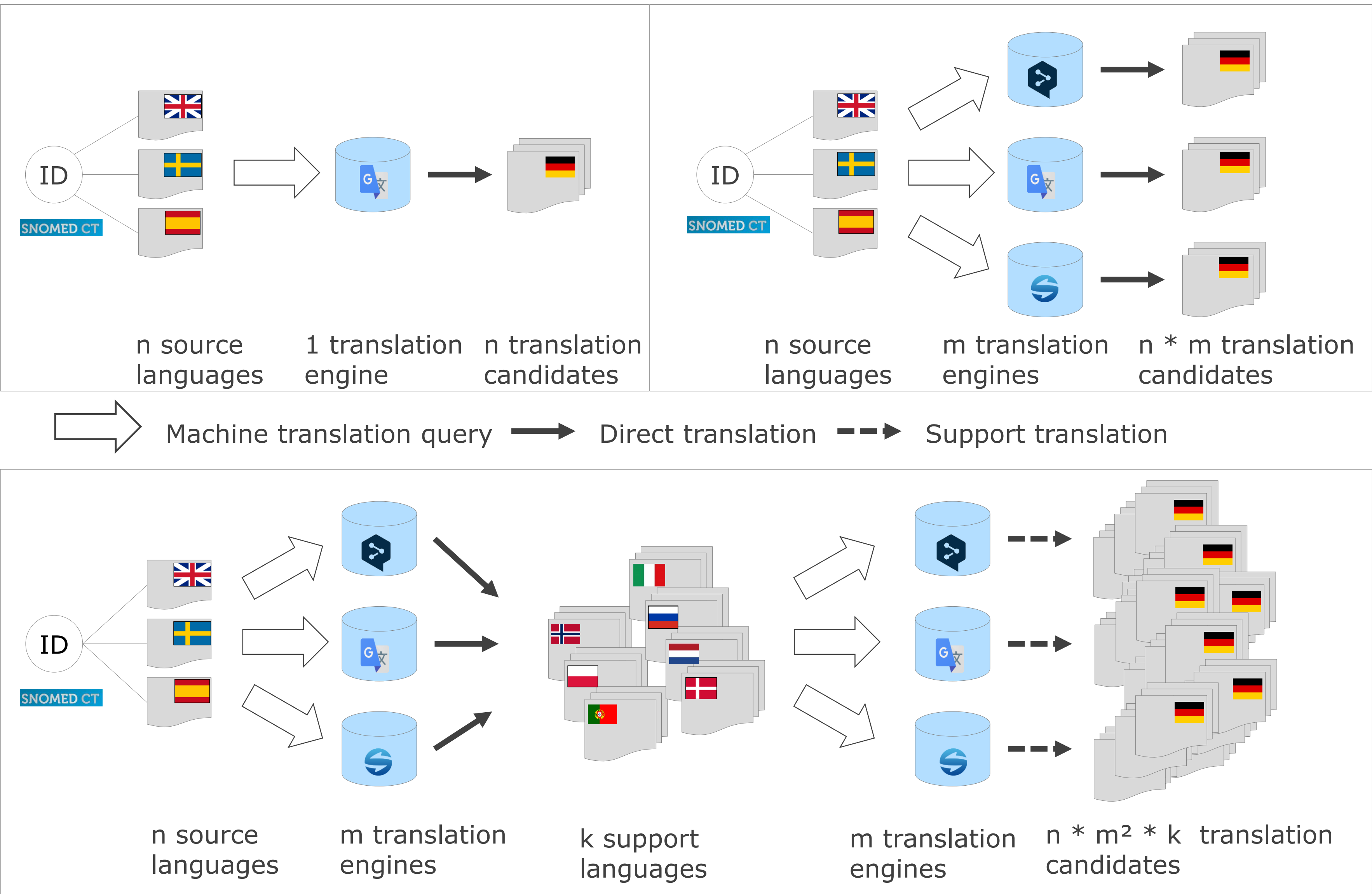
- Terminology translation is time-consuming and expensive
- SNOMED CT: ~ 350 k concepts, updated twice a year
- Two localization strategies:
 - (i) Focus on reference terminology aspects: translation of labels and few, unambiguous synonyms
 - (ii) Focus on interface terminology aspects: mapping clinical jargon to reference terminology



Web-based translation tools have made spectacular progress

- Google Translate, DeepL, Systran, among others, benefit from huge amounts of training data and deep learning technology
- Their quality regarding the translation of specialized terminology is still limited
- We believe that machine translation is becoming increasingly important to support human translation activities regarding large domain terminologies such as SNOMED CT

The Multiple Translation Paths (MTP) method presented here combines SNOMED CT source languages, intermediate support languages and translation engines in order to obtain a high variety of translation candidates. Preference is given to the candidates of highest frequency



UK	Pemphigus (disorder)
Spain	pénfigo (trastorno)
France	Pemphigus
Sweden	pemfigus

German translation candidates	relative score
Pemphigus	100%
Penfigo	10%
Pemfigus	5%
Pemfigo	5%
Pope Pemphigus	1%

UK	Abnormal granulation tissue (disorder)
Spain	tejido de granulación anormal (trastorno)
France	Tissu de granulation anormal
Sweden	onormal granulationsvävnad

German translation candidates	relative score
Abnormales Granulationsgewebe	100%
Abnormales Granulatgewebe	10%
Abnormes Granulationsgewebe	5%
Abnormes Granulat	5%
Anormales Granulationsgewebe	1%

Multiple Translation Paths (MTP) Validation: Four German Benchmarks

- BfArM Catalogue: value sets for different use cases mapped to SNOMED CT, enriched with synonyms
- SNOMED-CT (2003): unofficial German translation of an early version of SNOMED CT
- SNOMED-CT (2021): random subset of the January 2021 version translated by students
- Starter-set: a subset of 6006 popular SNOMED CT concepts

	BfArM Catalogue	SNOMED-CT (2003)	SNOMED-CT (2021)	SNOMED-CT (Starter-set)
Exact match				
MTP (rank 1-5)	73.90 +/- 1.49	29.96 +/- 0.95	77.91 +/- 1.26	55.35 +/- 1.27
MTP (rank 1-4)	72.40 +/- 1.41	28.71 +/- 0.91	75.49 +/- 1.35	51.98 +/- 1.46
MTP (rank 1-3)	69.57 +/- 1.43	27.15 +/- 0.98	72.27 +/- 1.44	49.54 +/- 1.61
MTP (rank 1-2)	65.26 +/- 1.44	23.88 +/- 0.80	65.98 +/- 1.59	44.71 +/- 1.53
MTP (rank 1)	54.23 +/- 1.56	17.60 +/- 0.88	51.99 +/- 1.67	35.29 +/- 1.63
en--google--de	50.11 +/- 1.71	17.07 +/- 1.33	45.84 +/- 1.60	32.91 +/- 1.53
en--deepl--de	43.21 +/- 1.01	19.41 +/- 1.12	41.18 +/- 1.68	33.35 +/- 1.39
es--google--de	37.92 +/- 1.63	13.21 +/- 1.17	40.56 +/- 1.44	28.95 +/- 1.37
es--deepl--de	37.85 +/- 1.31	14.17 +/- 0.97	35.64 +/- 2.09	29.63 +/- 1.61
en--systran--de	37.32 +/- 1.54	14.57 +/- 1.30	29.51 +/- 1.56	29.7 +/- 1.57
sv--google--de	33.48 +/- 1.40	10.39 +/- 1.02	28.66 +/- 1.49	25.77 +/- 1.38
sv--systran--de	23.72 +/- 1.42	7.38 +/- 0.87	16.07 +/- 1.41	20.68 +/- 1.17
es--systran--de	22.31 +/- 1.23	7.72 +/- 0.94	19.10 +/- 1.31	16.03 +/- 0.82

Metrics

- Percentage of exact match (excluding capitalization and hyphenation)
- BLEU score (standard machine translation benchmark, cf. Papinemi et al., ACL 2002)
- 10 different random choices of 500 terms (among a total of 1000 MTP-translated terms) for each benchmark, presented as mean with standard deviation
- Only MTP rank 1 is directly comparable with direct translations (the translation engines used only produce single results)

	BfArM Catalogue	SNOMED-CT (2003)	SNOMED-CT (2021)	SNOMED-CT (Starter-set)
BLEU metric				
MTP (rank 1-5)	0.93 +/- 0.01	0.50 +/- 0.01	0.80 +/- 0.01	0.62 +/- 0.01
MTP (rank 1-4)	0.91 +/- 0.01	0.48 +/- 0.01	0.78 +/- 0.01	0.60 +/- 0.01
MTP (rank 1-3)	0.89 +/- 0.01	0.44 +/- 0.01	0.75 +/- 0.01	0.56 +/- 0.01
MTP (rank 1-2)	0.86 +/- 0.01	0.38 +/- 0.01	0.68 +/- 0.01	0.49 +/- 0.01
MTP (rank 1)	0.75 +/- 0.01	0.28 +/- 0.01	0.53 +/- 0.01	0.35 +/- 0.01
en--google--de	0.69 +/- 0.01	0.30 +/- 0.01	0.51 +/- 0.01	0.34 +/- 0.01
en--deepl--de	0.69 +/- 0.01	0.32 +/- 0.01	0.47 +/- 0.01	0.34 +/- 0.01
sv--google--de	0.51 +/- 0.01	0.31 +/- 0.01	0.55 +/- 0.01	0.41 +/- 0.02
en--systran--de	0.58 +/- 0.01	0.26 +/- 0.01	0.43 +/- 0.01	0.33 +/- 0.01
es--google--de	0.55 +/- 0.01	0.23 +/- 0.01	0.48 +/- 0.01	0.31 +/- 0.01
es--deepl--de	0.53 +/- 0.01	0.26 +/- 0.01	0.45 +/- 0.01	0.31 +/- 0.01
sv--systran--de	0.41 +/- 0.01	0.25 +/- 0.01	0.41 +/- 0.01	0.35 +/- 0.01
es--systran--de	0.39 +/- 0.01	0.18 +/- 0.01	0.34 +/- 0.01	0.22 +/- 0.01

Discussion

- 91 translation paths, mean of 28.7 distinct translations per code
- Result variations between benchmarks mainly depend on different synonym coverage
- A fraction of exact matches with the human translation is found by MTP only
- Several limitations
 - No assessment of relative gain of specific translation paths, support languages, and/or language combinations
 - No assessment of the use of synonyms from English and Spanish SNOMED CT as additional input terms
 - Translation engines under scrutiny produce only one translation output
 - Translation engines trained on the web are not expected to translate into typical clinical jargon – MTP of limited use for constructing clinical interface terminologies (cf. Hashemian Nik et al. MEDINFO 2019)

Outlook

- Currently we would MTP recommend mainly as a shortlist creator to facilitate human translation of SNOMED CT preferred terms, particularly for minor languages
- To be further explored: grammatical patterns that predict bad translation outcomes, e.g. concatenation of adjectives and nouns in English without prepositions.

Fibula osteocutaneous free flap reconstruction	UK	Rekonstruktion des osteokutanen freien Lappens der Fibula	🔴
reconstrucción con colgajo libre osteocutáneo peroneo	Spain	Rekonstruktion mit freiem osteokutanem Fibulalappen	🟢
rekonstruktion med osteokutan fri fibulalambå	Sweden	Rekonstruktion mit osteokutaner freier Fibula lamba	🟡

Accessibility of data and demonstrator / Contact

- Demonstrator (limited to starter set concepts) : <https://cutt.ly/SCTMTP>
- Supplementary material on GitHub: <https://github.com/andreaprunotto>
- Long manuscript submitted to MIE: <https://cutt.ly/MTPMIE>

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