# Using **morphological tags** via **custom embeddings** improves **interlinear translation** performance by **35%**.

## Low-Resource Interlinear Translation: Morphology-Enhanced Neural Models for Ancient Greek

AGH
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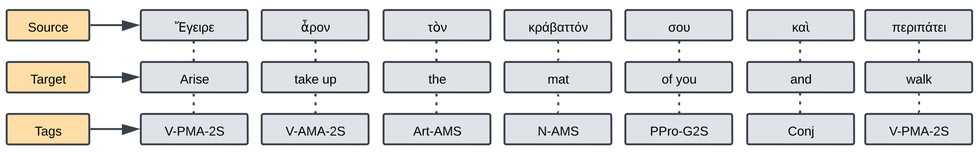
πλεῖον γνῶθι

## 1. Background

- Translation method that preserves source text structure by aligning each target word directly beneath its corresponding source counterpart
- Enables understanding of original text's meaning and structure without source language expertise
- Primarily used for ancient and sacred texts (e.g., Odyssey, Bible)




## 2. Questions

- Can modern MT models effectively perform **interlinear translation** from **Ancient Greek?**
- Does incorporating **morphological information** improve translation quality in **low-resource settings**?
- How do specialized ancient language models (**PhilTa, GreTa**) compare to general multilingual models (**mT5**)?
- What impact do **text preprocessing** methods and **morphological tag sets** have on translation performance?

## 3. Methodology

### Dataset

- Two word-level-aligned interlinear translations of the Greek New Testament:
  - English translation from biblehub.com
  - Polish translation from oblubienica.eu

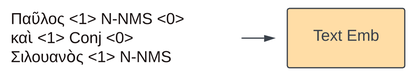
### Experimental Setup (144 configurations)

- **Target Language (2):** English, Polish
- **Base Models (4):** mT5-{base, large}, GreTa, PhilTa
- **Text Preprocessing (2):** raw, without diacritics
- **Tag Sets (2):** BibleHub (#693), Oblubienica (#1,068)
- **Input Encoding Methods (5):**
  - Text only (baseline)
  - Tags within text (t-w-t)
  - Morphological embeddings (3 variants)

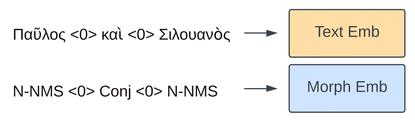
### Input Encoding Methods

a) Baseline


b) Tags Within Text (t-w-t)



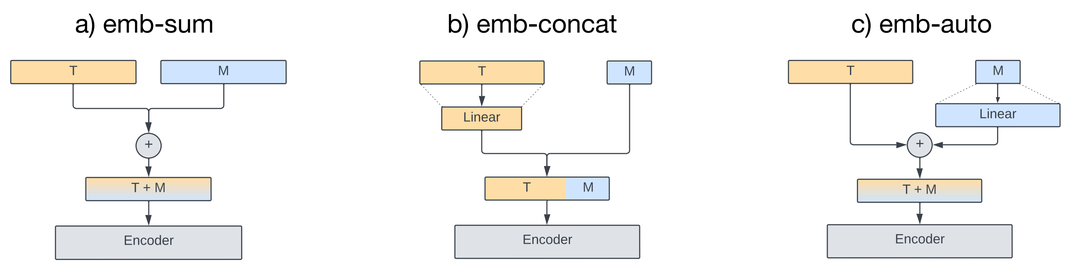

c) Morphological Embeddings (emb-*)




### Morphological embeddings

Three approaches to combining text and morphological embeddings:

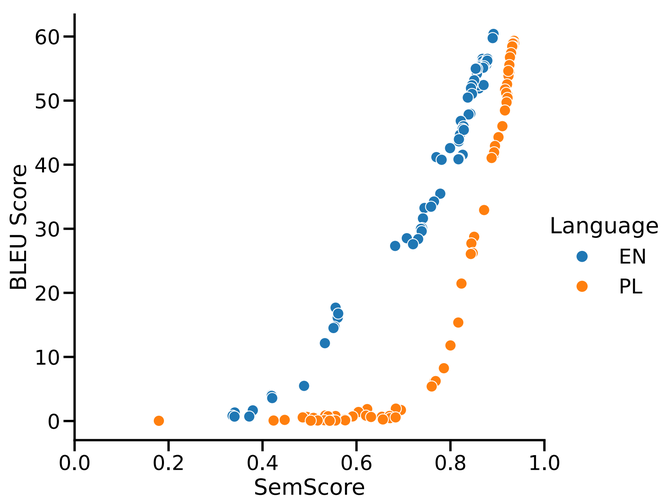
- emb-sum — Direct element-wise addition
- emb-concat — Compress both, then concatenate
- emb-auto — Compress-decompress tags before addition




## 4. Results

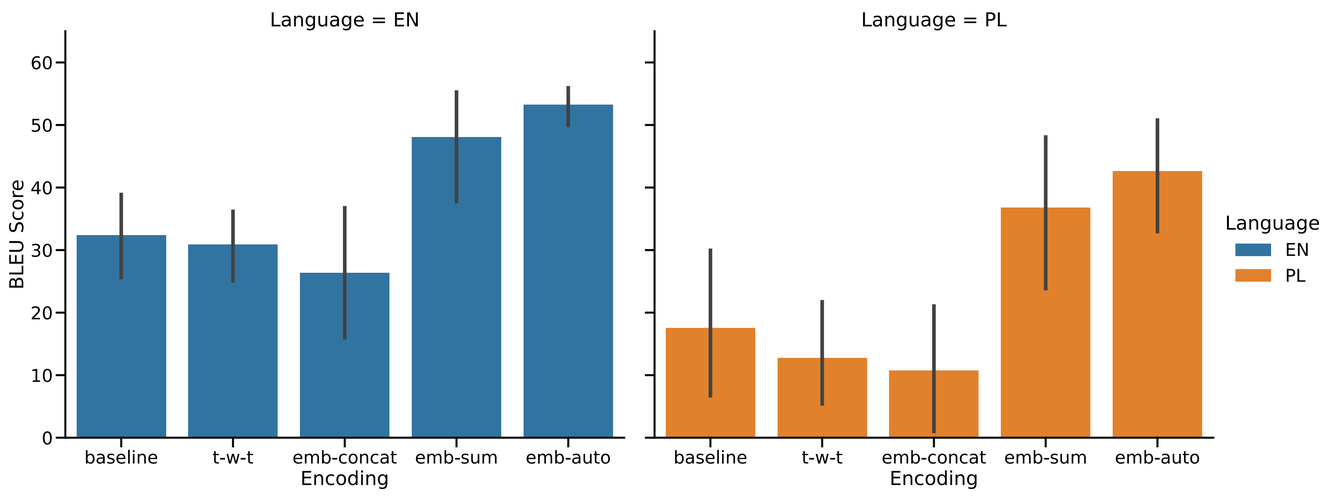
### Overall Translation Quality

Translation performance across 144 experiments: BLEU and SemScore.



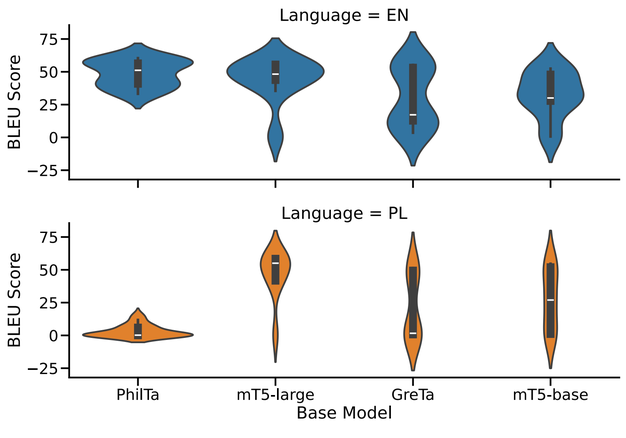

### Impact of Morphological Tags

Effect of different morphological encoding strategies on translation quality.



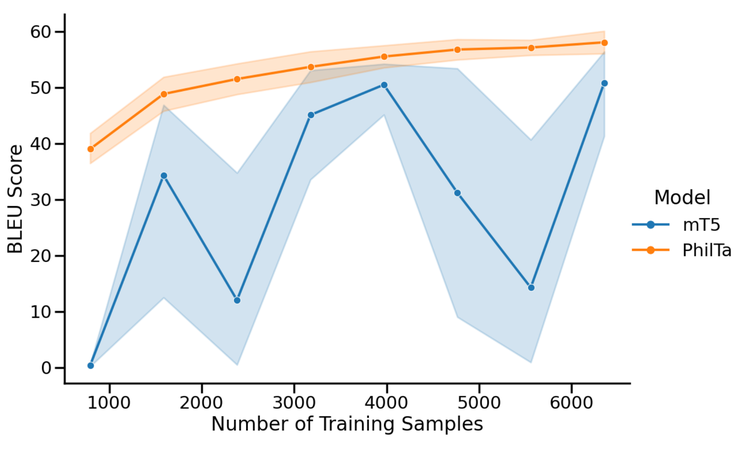

### Base Model Comparison

Performance comparison of GreTa, PhilTa, mT5-base, and mT5-large models.




### PhilTa vs mT5 - Learning Efficiency

Performance on translation into English with varying training data split sizes (10 — 80%).




## 5. Conclusions

- Successfully automated interlinear translation from **Ancient Greek (BLEU > 60, SemScore > 0.8)** for both **English** and **Polish**.
- Morphological embedding approach significantly improved translation quality:
  - **+35%** for English (BLEU **44.67** → **60.40**)
  - **+38%** for Polish (BLEU **42.92** → **59.33**)
- **PhilTa** with remarkable **efficiency** in **low-resource settings** — stable performance with just **10% of training data**.
- **no significant impact** of **text normalization** and **tag set selection**.