

# Efficacy of ByT5 in Multilingual Translation of Biblical Texts for Underrepresented Languages



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## Motivating Problem

- Traditional human translation of sacred texts into underrepresented languages is very time-consuming and resource-intensive.
- The scarcity of skilled translators for these languages delays the availability of important cultural & religious texts.
- Advanced models like ByT5 can enhance the accuracy of these translations, improving accessibility to sacred literature.

## Contributions

- Developed a ByT5-based multilingual translation model tailored for translating the Bible into underrepresented languages.
- Trained the model on the Johns Hopkins University Bible Corpus to capture intricate linguistic nuances of character-based and morphologically rich languages.
- Achieved significant improvements in translation quality and accessibility of sacred texts for underrepresented languages using the BLEU score and sample translations.

## Methodology Overview

### 1. Model Selection and Training:

- The ByT5 model was chosen for its proficiency in byte-level tokenization, which is crucial for handling subtle linguistic differences in underrepresented languages.
- The dataset used was the Johns Hopkins University Bible Corpus, encompassing a wide array of linguistic variations, providing a comprehensive foundation for the model.

### 2. Parameter Tuning:

- The training hyperparameters were optimized through an iterative experimental protocol, focusing on adjusting the learning rate (LR), early stopping, patience, and batch size.
- Final configuration: an LR of 0.0002, a scheduler factor of 0.5, patience of 10, a batch size of 48, and 50 max epochs, with early stopping typically occurring around epoch 43.

### 3. Data Handling:

- The dataset comprised 3 million pairs of source-target translations, cleaned and aligned to ensure verse-parallel structure, which is ideal for machine learning applications.
- A byte-level tokenization enabled the model to handle character-based and morphologically rich languages, leading to better generalization across languages.

### 4. Evaluation Metrics:

- The translation quality was assessed using the BLEU score, comparing the model's outputs with human translations.
- Additional qualitative analysis was conducted through a series of sample translations highlighting its capability.

The translations below illustrate ByT5's ability to produce accurate translations across multiple languages, demonstrating its effectiveness in maintaining semantic integrity and handling diverse linguistic structures, particularly for underrepresented languages.

Language	Target text	Translated text
English	Jesus heard that John was put in prison, so he went back to Galilee.	When Jesus heard that John had been arrested, he went back to Galilee.
	And He warned them to tell no one about Him.	And he charged them that they should tell no man of him.
	Today your Savior was born in David's town. He is Christ, the Lord.	for today in the city of David a Saviour was born to you, which is Christ the Lord.
Spanish	porque decia : « Si toco tan sólo su manto , seré salva . »	Porque decia: Si tocare tan solamente su vestido, seré salva.
	y diciendo : « Tú , el que derribas el Templo y en tres dias lo reedificas , sálvate a ti mismo . Si eres Hijo de Dios , desciende de la cruz . »	y diciendo: Tú, el que derribas el templo, y en tres días lo reedificas, sálvate a ti mismo. Si eres Hijo de Dios, desciende de la cruz.
	Jesús salió llevando su cruz , para ir al llamado « Lugar de la Calavera » ( que en hebreo se llama Gólgota ) .	Y llevando su cruz, salió al lugar que se dice de la Calavera, y en hebreo Gólgota.
Marathi	म्हणून ज्याच्याविषयी तो बोलतो तो कोण आहे हे आम्हास सांग, असे शिमोन पेत्राने त्यास खुणावून म्हटले.	शिमोन पेत्राने त्या शिष्याला खुणावले आणि म्हणाला, "ज्याच्याविषयी तो बोलतो तो कोण आहे हे विचार.
	आणि तेथे काही मंदपाळ रात्रीच्या वेळी शेतामध्ये राहून आपले कळप राखीत होते.	आणि तेथे काही मंदपाळ रात्रीच्या वेळी शेतामध्ये राहून आपले कळप राखीत होते.
	तर आता काय करावे? तुम्ही आला आहात हे ते खात्रीपूर्वक ऐकतील.	"मग आता काय केले पाहिजे? तू येथे आला आहेस हे त्यांना नक्की कळेल.
Chinese	完,他又告他:"我的朋友拉撒路睡着了,我去叫醒他。"	完,他又告他:"我的朋友拉撒路睡着了,我去叫醒他。"
	当他,么做很好犹太人,便索性又把彼得也抓了起来。(当正逾越期)	当他,么做很好犹太人,便索性又把彼得也抓了起来。(当正逾越期)
	因我有五个兄弟,拉撒路告他,以便将来他不会到个受尽折磨的地方来。'	因我有五个兄弟,拉撒路告他,以便将来他不会到个受尽折磨的地方来。'

Below are additional sample translations generated by ByT5, accurately translating complex religious narratives across a variety of languages, including those that are character-centric and underrepresented.

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