Software Engineering Department

ORT Braude College

Course 61771 - Extended Project in Software Engineering

Prose Style Transferring Agent Document

In Partial Fulfillment of the Requirements for

Final Project in Software Engineering (Course 61771)

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Abstract: *In the prose style transfer task a system, provided with text input and a target prose style, produced output which preserves the meaning of the input text but changes the style. These systems require parallel data to assessment the results and use with parallel data for training. Currently, there are some publicly available corpora for this task. In this work, we identify a high-quality source of text that aligned and distinct in different versions of the bible. We provide a standard split, into training, development and testing data, of our public domain corpus versions. The corpus is parallel because many bible versions are included inside him. The sentences in the corpus is aligned due to the presence of chapter and verse numbers in the text. In addition to the corpus, we present the results, as measured by the BLEU (bilingual evaluation understands) metrics of several models that have been trained on our data, which can act as base for future research. While we present these data as a style transfer corpus, we believe that this may be useful for other natural language tasks as well.*
Keywords: *Recurrent Neural Networks, Prose Style transfer, Sequence to sequence (Seq2Seq), BLEU (bilingual evaluation understand) metrics.*

1. INTRODUCTION

Written prose is one way that we can communicate our thoughts to each other. Given a message, there are many ways to write a sentence that capable to pass the information, even when they are all written in the same language. Sentences can actually communicate the same information but makes that with various styles.

When writing a sentence, we refer not only the semantic content we want to communicate, but also the style, or manner, that we express it. Another wording may convey different levels of familiarity or politeness with the reader, which present different cultural information about the writer, and being easier to understand for particular populations.

Style transfer is the task of rewriting a sentence, its mean we need to preserve the meaning but change the style. There are a lot of characters of the prose that can contribute to the style transfer of the text including vocabulary level, using with passive or active voice, sentence length, tone and level of formality.

Systems typically require parallel data in the corpus for testing and training their results. The parallel data is intended for evaluation. We believe that one of the main obstacles for style transfer is the relatively low amount of parallel data in the corpus. The main contributions of our work are identification of high parallel corpus and publication of basic results for our corpus [1].

1.1. Organization of the paper

Section 2 - we start by recurrent neural network as the basic architecture for style transfer modeling, and how it is related to additional models in details. Section 3 - we propose architecture for style transferring while our goal is to make style transfer from source prose to target prose with sequence to sequence (Seq2Seq) model. Section 4 - we briefly discuss the expected result that we want to get. Section 5 - consist of preliminary software engineering documents - use case, class diagram, sequence diagram, and initial GUI, concluded by a short text plan section.

2. BACKGROUND

2.1. Neural Network

Neural network is a biologically inspired programming pattern that allows to computers to learns from observed data. It consists of many interconnected processing elements, neurons, and working together to solve a problem. In neural network, all the inputs, and outputs are independent from each

other, but for many tasks that results is a not a good performance. If the next word in a sentence is predictable, it is necessary to know which word came before it, and for that we need the recurrent neural network (RNN) for sequential information [2].

Neural network is a major part of artificial intelligence which allows networks to adjust this hidden layer in situations where the result doesn't match the hoping.

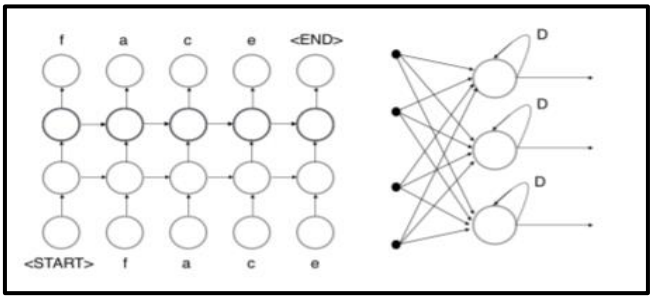

Figure 1 - Neural network
https://arxiv.org/pdf/1703.03091.pdf

2.2. Recurrent Neural Networks

Recurrent neural network (RNN) is a neural network that include from output *y* and hidden state *h* which operates on a variable length sequence x = $(x_1, \dots, x_t)$. In RNN there have a loop, which allow information to persist. The hidden state $h_{\langle t \rangle}$ of the RNN, at each time step *t*, is updated by -

$$h_{\langle t \rangle} = f(h_{\langle t-1 \rangle}, x_t)$$

Equation 1 – The hidden state of RNN

RNN can learn the probability of distribution across a sequence by being trained to predict the next symbol in a sequence. In that case, at each timestamp *t*, the output is the conditional distribution $p(x_t | x_{t-1}, \dots, x_1)$.

A multinomial distribution (1-of-K coding) can be output by using a SoftMax activation function for all possible symbols $j = 1, \dots, K$, where w_j are the rows of a weight matrix *W* [3].

$$p(x_{t,j} = 1 | x_{t-1}, \dots, x_1) = \frac{\exp(w_j h_{\langle t \rangle})}{\sum_{j'}^{K} \exp(w_{j'} h_{\langle t \rangle})}$$

Equation 2 – SoftMax activation function

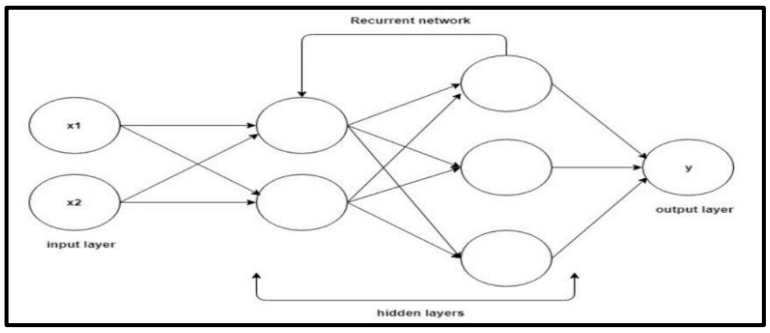

Figure 2 – Recurrent Neural network
https://hackernoon.com/rnn-or-recurrent-neural-network-for-noobs-a9afbb00e860

2.2.1. Bidirectional RNN

The idea which the output at time *t* may not only depend on the previous elements in the sequence, but also future elements, is the base of Bidirectional RNN's.

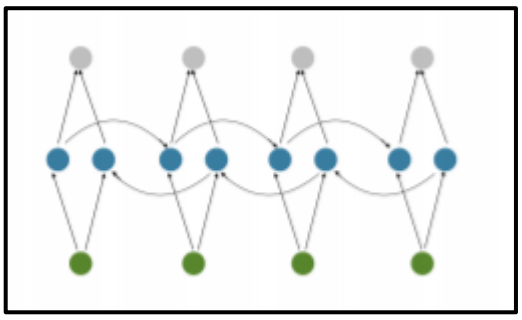

Figure 3 – Bidirectional Recurrent Neural network

https://arxiv.org/pdf/1703.03091.pdf

2.2.2. Deep RNN

Deep RNNs are similar to Bidirectional RNN's, only that we now have multiple layers per time step. In practice Deep RNN gives us a higher learning capacity, but we also need more training data.

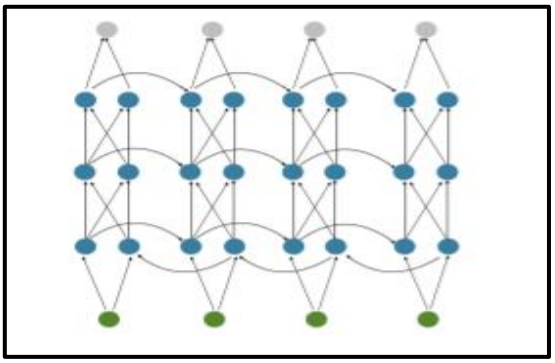

Figure 4 – Bidirectional Recurrent Neural network

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2.2.3. RNN Parameters

In RNN there have three matrixes –

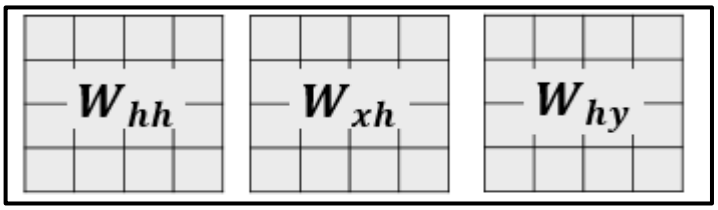


Figure 5 – RNN's Matrixes

In training, these matrixes initialized with random numbers. We try to get the matrixes that give rise to desirable behavior, as measured with some loss of function that expresses our preferences to what kinds of outputs *y*, we like to see in response to our input sequence *x*.

2.2.4. How RNN Memorizes

RNN steps –

1. Update the hidden state –

$$h_t = \tanh\left(W_{hh}h_{t-1} + W_{xh}x_t\right)$$

Equation 3 – Hidden state

2. Compute the output vector –

$$y_t = w_{hy}h_t$$

Equation 4 – Vector in RNN

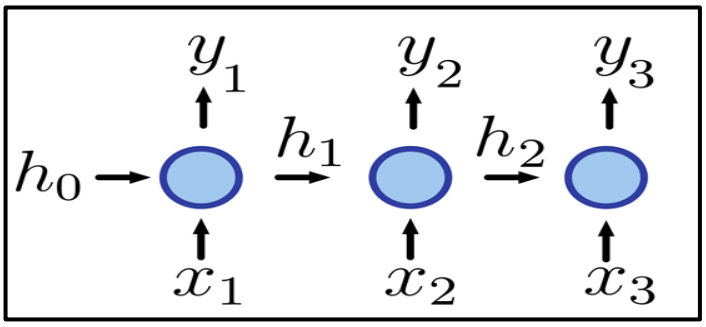


Figure 6 – RNN steps

2.2.5. Multi-Layer RNN

We can form a 2-Layer recurrent neural network as follows –

$$y_1 = RNN_1.step(x)$$

$$y_2 = RNN_2.step(y_1)$$

First, RNN is receiving the input vectors. Second, RNN is receiving the output of the first RNN as an input. In fact, RNN with multiple layers is made by independent RNN's that not know each other and only pass the output of one of them as input of the others.

2.3. RNN Encoder-Decoder

RNN architecture learns to encode a variable sequence into a fixed vector representation and to decode given fixed vector representation back into a variable sequence.

The encoder is an RNN that reads each symbol of an input sequence *x* sequentially. When the encoder finish to reads all the symbols, the hidden state of the RNN changes according to Equation (1). After the encoder reading the end of the sequence, the hidden state of the RNN is a summary *c* of the whole input sequence.

The decoder of the recommended model is another RNN which is trained to produce the output sequence by predicting the next symbol y_t given the hidden state $h_{\langle t \rangle}$.

$$h_{\langle t \rangle} = f\left(h_{\langle t-1 \rangle}, y_{t-1}, c\right)$$

Equation 5 – The hidden state of decoder at time t

Once the RNN Encoder-Decoder is trained, the model can be used in two ways. The first way is to use the model for generating a target sequence given an input sequence. The second way is to use the model for scoring a given pair of input and output sequence.

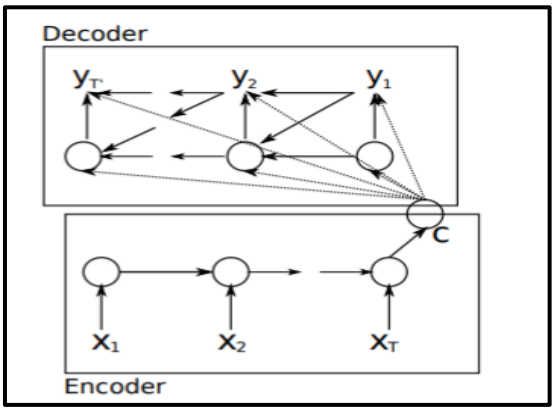


Figure 7 – RNN Encoder-Decoder
https://arxiv.org/pdf/1406.1078.pdf

2.3.1. RNN Encoder

Let us denote a source phrase by $X = (x_1, x_2, \dots, x_N)$ and target phrase by $Y = (y_1, y_2, \dots, y_M)$. Each phrase is a sequence of K-dimensional vectors, such that only one element of the vector is 1 and all the others are 0. The index of the active element indicates the word represented by the vector.

Each word of the source phrase is embedded in a 500-dimensional vector space: $e(x_i)\ \epsilon\ R^{500}$. The hidden state of encoder consists of 1000 hidden units and each one of them at time *t* is computed by -

$$h_j^{\langle t \rangle} = z_j h_j^{\langle t-1 \rangle} + (1 - z_j)\tilde{h}_j^{\langle t \rangle}$$

Equation 6 – The hidden state of encoder at time t

$$\tilde{h}_j^{\langle t \rangle} = \tanh\left([We(x_t)]_j + [U(r \odot h_{\langle t-1 \rangle})]_j\right)$$

$$z_j = \sigma([W_z e(x_t)]_j + [U_z h_{\langle t-1 \rangle}]_j)$$

$$r_j = \sigma([W_r e(x_t)]_j + [U_r h_{\langle t-1 \rangle}]_j)$$

Equation 7 – Parameters that belongs to Equation (4)

σ and $\odot$ are logistic sigmoid function and an element-wise multiplication, respectively. Once the hidden state at the N step (the end of the source phrase) is computed, the representation of the source phrase *c* is –

$$c = \tanh\left(Vh^{\langle N \rangle}\right)$$

Equation 8 – Representation of source phrase

2.3.2. RNN Decoder

The decoder starts by initialized the hidden state with -

$$h'^{\langle 0 \rangle} = \tanh(V'c)$$

Equation 9 – The Initialized hidden state of decoder at time t

The hidden state at time *t* of the decoder is computed by -

$$h'_j{}^{\langle t \rangle} = z'_j h'_j{}^{\langle t-1 \rangle} + (1 - z'_j)\tilde{h}'_j{}^{\langle t \rangle}$$

Equation 10 – The hidden state of decoder at time t

$$\widetilde{h'}_j^{\langle t \rangle} = \tanh\left([W'e(y_{t-1})]_j + r'_j[U'h'_{\langle t-1 \rangle} + C_c]\right)$$

$$z'_j = \sigma([W'_z e(y_{t-1})]_j + \left[U'_z h'_{\langle t-1 \rangle}\right]_j + [C_z c]_j)$$

$$r'_j = \sigma([W'_r e(y_{t-1})]_j + \left[U'_r h'_{\langle t-1 \rangle}\right]_j + [C_r c]_j)$$

Equation 11 – Parameters that belongs to Equation (8)

Unlike the encoder which simply encodes the source phrase, the decoder is learned to create a target phrase. The decoder computes the probability of creating j word by Equation (2).

2.3.3. Tanh

Is a hyperbolic tangent function which is a rescaled logistic sigmoid function that its output range is [-1, 1]. The relationship between the value of the function at a point and his derivative reduces the computational burden during training according to Fausset.

$$\tanh(x) = 2g(2x) - 1$$

Equation 12 – Tanh(x) with g(x) as parameter

$$g(x) = \frac{e^x}{1 + e^{-x}}\ ,\ \tanh(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}$$

Equation 13 – Sigmoid function [0, 1] , Equation 12 – Tanh(x)

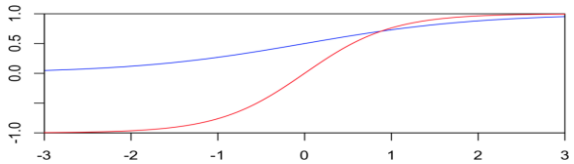


Figure 8 – Tanh(x) function (red)

https://brenocon.com/blog/2013/10/tanh-is-a-rescaled-logistic-sigmoid-function/

2.4. Style Transfer

Style transfer is known by the technique of recomposing a source image or text into the style of other target image of text. The content of the source stays the same with a different style, more likely as the target destination style.

2.5. Machine Learning

There are several approaches for Machine Learning. The most significant is data mining. When People try to make relationship between multiple features, they often making mistakes during the analyses. Therefore, finding solutions to different problems is difficult to them.

Machine learning can often be successfully applied to these problems. Furthermore, Machine learning can improve the efficiency of systems and the designs of machines. Each instance of dataset that used by machine learning represented set of features that identical. The set of features can be continuous, categorial or binary. If instances are given with known labels, then the learning is called supervised, otherwise it called unsupervised [4].

2.5.1. Supervised Learning

In supervised learning, we have training data encoded as pairs where the correct output is often manually annotated, and the learning goal is to adjust these parameters in order to fit the data. Types of features used to represent the input and varying degree of complexity [5].

2.5.2. Unsupervised Learning

In unsupervised learning, we try to learn the underlying patterns of our data. If there any correlations between that features, we can cluster our dataset into few groups which behave similarly.

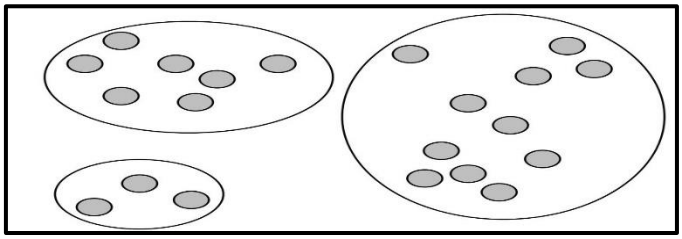


Figure 9 – Example of unsupervised data

2.6. Natural Language Processing

The field of natural language processing aims to convert human language into a formal representation is easy to computer to manipulate. Today, there have applications that includes information , machine translation, summarization, search and human computer interfaces.

2.6.1. Tasks

The first task is part-of-speech tagging. This task labeling each word with a unique tag that indicates on syntactic role, for example – plural noun, verbs. The second task is chunking, also called shallow parsing. This task labeling segments of a sentence with syntactic constituent such as noun or verb phrase. Each word is assigned only one unique tag, often encoded as a begin chunk or inside chunk tag.

The third task is entity recognition. This task labeling atomic elements in the sentence into categories such as person, company, or location. The fourth task is semantic role. This task labeling a semantic role to syntactic constituent in a sentence. The fifth task is language models. A language model traditionally estimates the probability of the next word in a sequence. The sixth task is semantically related words. This task predicting whether two words are semantically related [6].

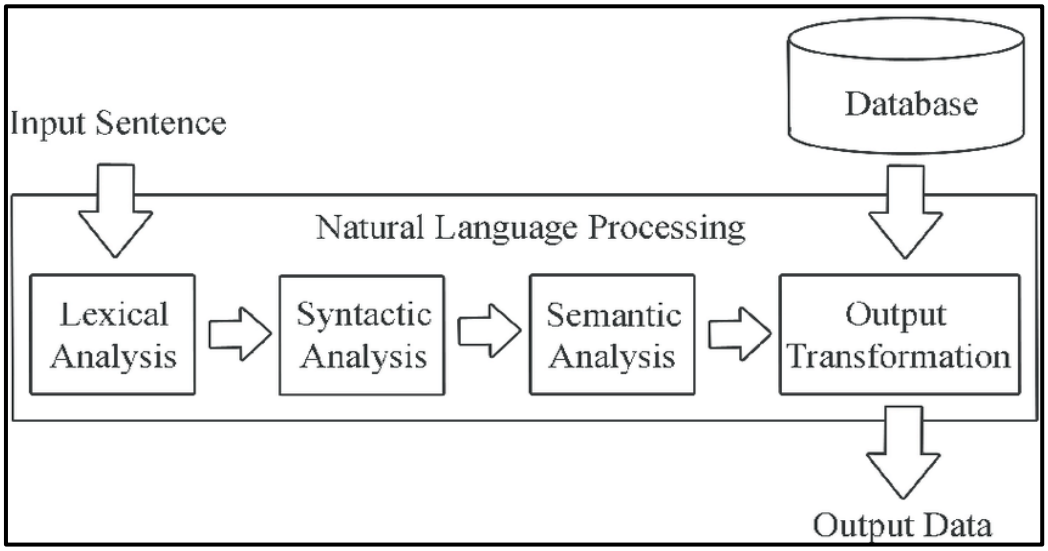


Figure 10 – Natural language processing

2.7. Deep Learning

Deep learning refers to class of machine learning techniques, where many layers of information processing stages in hierarchical architectures are exploited for pattern classification and for feature or representation learning.

Deep learning techniques developed so far two additional key properties - The generative nature of the model, which typically requires adding an additional top layer to perform discriminative tasks, and an unsupervised pretraining step that makes an effective use of large amounts of unlabeled training data for extracting structures and regularities in the input features [7].

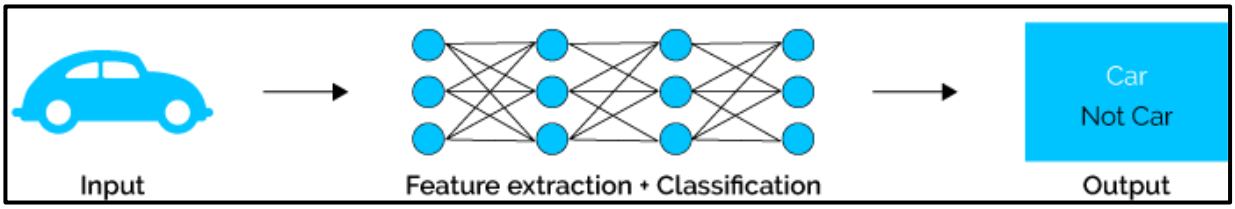


Figure 11 – Example of unsupervised data

2.8. Long-Short Term Memory

Long short-term memory was introduced to allow a recurrent neural network to store information for an extended period [1]. The LSTM has complicated dynamics that allow it to easily memorize information for an extended number of timestamps.

The long-term memory is stored in a vector of memory cells. Although many LSTM architectures that differ in their connectivity structure and activation functions, all LSTM architectures have explicit memory cells for storing information for long periods of time. The LSTM can decide to overwrite the memory cell, retrieve it, or keep it for the next timestamp [8].

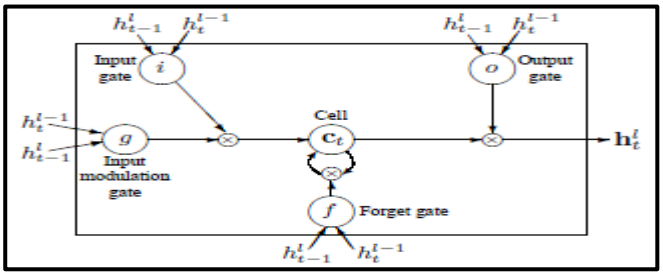


Figure 12 – Graphical representation of LSTM memory cells

https://arxiv.org/pdf/1409.2329.pdf

2.9. Sequence to Sequence

The Sequence to sequence model was created and used in conjunction with statistical methods to perform machine translation. The model consists of a recurrent neural network acting as an encoder, which generate an embedding of the full sequence of inputs. This sentence is then used by another recurrent neural network which acts as a decoder and generate a sequence that corresponding to the original input sequence. The Sequence to sequence model was adapted to use multiple LSTM (Long-short term memory) layers for the encoder side and the decoder side.

The model receives two languages as a pair and can learn to translate between them although they never appeared in the training data. The model adds artificial tags at the beginning of each source example to indicate the languages that belongs to the target during the decoding process. These models generally require many training examples to produce high-quality results.

For Sequence to sequence model there have three multi-task learning settings: (a) the *One-to-Many* setting – where the encoder is shared between some tasks such as machine translation and syntactic parsing, (b) the *Many-to-One* setting – useful when only the decoder can be shared, as in the case of translation and image caption generation, and (c) the *Many-to-Many* setting – where multiple encoders and decoders are shared, which is the case unsupervised objectives and translation.

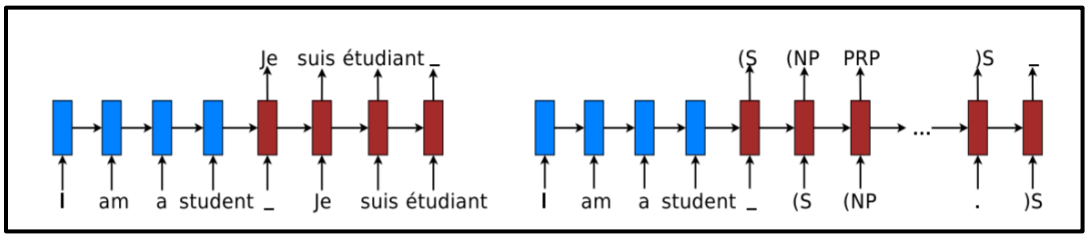


Figure 13 – Sequence to sequence learning example – (left) machine translation , (right) constituent parsing

https://arxiv.org/pdf/1511.06114.pdf

2.9.1. Sequence to Sequence Learning

Sequence to sequence learning aims to directly model the conditional probability $p(y|x)$ of mapping an input sequence, $x_1, \dots, x_n$, into an output sequence, $y_1, \dots, y_n$. The encoder calculates a representation s for each input sequence. Base on that input representation, the decoder create output sequence, one unit at a time, and hence, decomposes the conditional probability as –

$$\log p(y|x) = \sum_{j=1}^{m} \log p(y_j \,|y < j\,, x\,, s)$$

Equation 14 – Tanh(x) with g(x) as parameter

2.9.2. One-to-Many setting

This scheme consists one decoder and multiple decoders for tasks in which the encoder can be shared. The input for each task is a sequence of English words. A separate decoder is used to generate each sequence of output units which can be either a sequence of tags for constituency parsing, for machine translation, and for autoencoders.

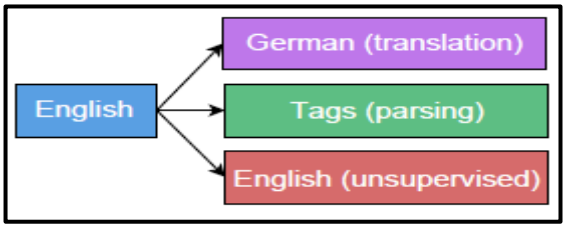


Figure 14 – One-to-Many setting: one encoder, multiple decoders. This scheme is useful for multi target translation, or between different tasks

https://arxiv.org/pdf/1511.06114.pdf

2.9.3. Many-to-One setting

This scheme is the opposite of the *One-to-Many* setting. It consists multiple encoders and one decoder. *Many-to-One* is useful for tasks which only the decoder can be shared, for example, when our tasks include machine translation and image caption generation. In addition, from a machine translation perspective, this setting can benefit from a large amount of monolingual data on the target side, which is a standard practice in machine translation system.

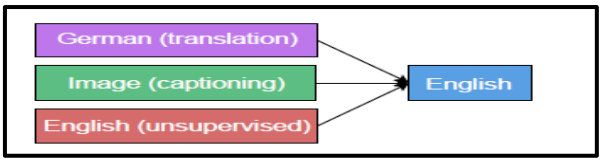


Figure 15 – Many-to-One setting: multiple encoders, one decoder. This scheme is handy for tasks in which only the decoder can be shared

https://arxiv.org/pdf/1511.06114.pdf

2.9.4. Many-to-Many setting

This scheme is the most general. It consists multiple encoders and multiple decoders. We consider this scheme in a limited context of machine translation to utilize the large monolingual corpora in both the source and the target languages [9].

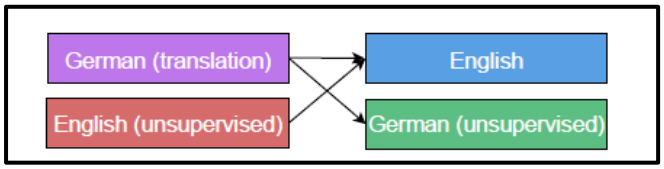


Figure 16 – Many-to-Many setting: multiple encoders, multiple decoders. This scheme consists single translation task and two unsupervised autoencoder tasks

https://arxiv.org/pdf/1511.06114.pdf

2.9.5. TensorFlow

Sequence to sequence model implemented using a publicly available library which itself makes use of the API provided by TensorFlow. TensorFlow is an interface for expressing machine learning algorithms, and an implementation for executing such algorithms.

TensorFlow express model parallel training where portions of the model computation are done on different computational devices simultaneously for the same batch of examples [10].

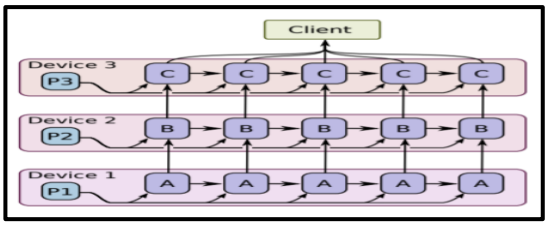


Figure 17 – Model parallel training: In this picture we have recurrent, deep LSTM model used for sequence to sequence learning

http://download.tensorflow.org/paper/whitepaper2015.pdf

2.10. Bilingual Evaluation Understandy (BLEU)

Bilingual evaluation understandy is a method for automatic machine translation evaluation. The method is quick, inexpensive, and language-independent, that correlates highly with human evaluation, and that has little marginal cost per run. The method is automated understandy skilled human judges which substitutes for them when there is need for quick or frequent evaluations.

Bilingual evaluation understandy only needs to match human judgment when averaged over a test corpus. Scores on individual sentences often vary from human judgments. The key to bilingual evaluation understandy success is that all systems are treated similarly and multiple human translators with different styles are used, so this effect cancels out in compressions between systems.

2.10.1. Baseline of Bilingual Evaluation Understandy (BLEU) metrics

Bilingual evaluation understandy (BLEU) is a metric for comparing parallel corpora which rewards a candidate sentence for having n-grams which also appear in the target. Although it was created for evaluation of machine translation, it has been found that the scores correlated with human judgement when used to evaluate paraphrase quality. The correlation was especially strong when the source sentence and candidate sentence differed by larger amounts over words. Typically, there are many perfect translations of a given source sentence. These translations may vary in word choice or in word order even when they use the same words.

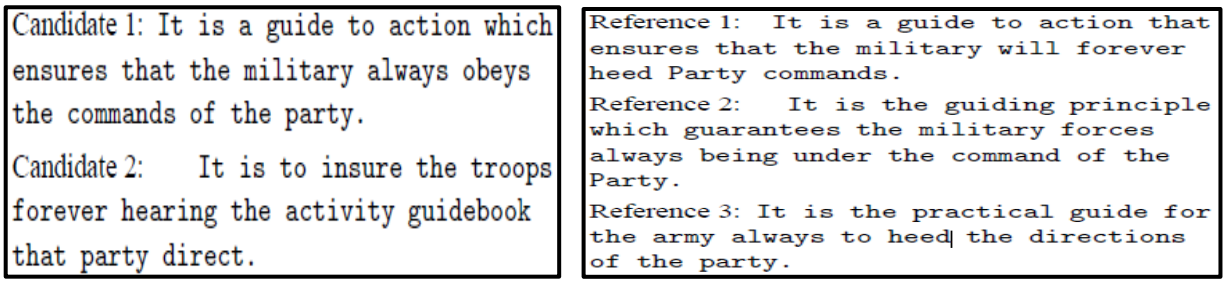


Figure 18 – Example of two candidate's translations of a Chinese source sentence, and three reference human translations of the same sentence

https://www.aclweb.org/anthology/P02-1040.pdf

According to Figure 10, although they appear to be on the same subject, they differ markedly in quality. The good translation is candidate 1, because he shares many words and phrases with these three references translations.

2.10.2. Modified *n*-gram Precision

The cornerstone of our metric is the familiar precision measure. To calculate accuracy, we counts the number of candidate translation words (unigrams) which occur in any reference translation and then divides by the total number of words in the candidate translation.

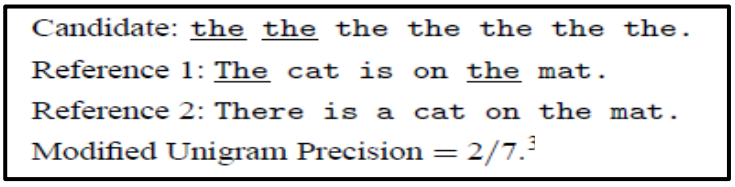


Figure 19 – Modified n-gram precision

https://www.aclweb.org/anthology/P02-1040.pdf

2.10.3. Modified *n*-gram Precision on blocks of text

A source sentence may translate too many target sentences, in which case we abuse terminology and refer to the corresponding target sentences. First, we compute *n*-gram that matches sentence by sentence. Next, we add the clipped *n*-gram counts for all the candidates sentences and divide them by the number of candidates *n*-grams in the test corpus to compute a modified precision score P_n for entire test corpus.

$$p_n = \frac{\sum_{C \in \{Candidates\}} \sum_{n-gram \in C} Count_{clip}(n-gram)}{\sum_{C' \in \{Candidates\}} \sum_{n-gram' \in C'} Count_{clip}(n-gram')}$$

Equation 15 – Modified precision score

2.10.4. Ranking systems using only Modified *n*-gram Precision

To verify that modified *n*-gram precision is different between very good translations and bad translations, we calculated the modified precision numbers on the output of a (good) human translation and a standard (poor) machine translation system.

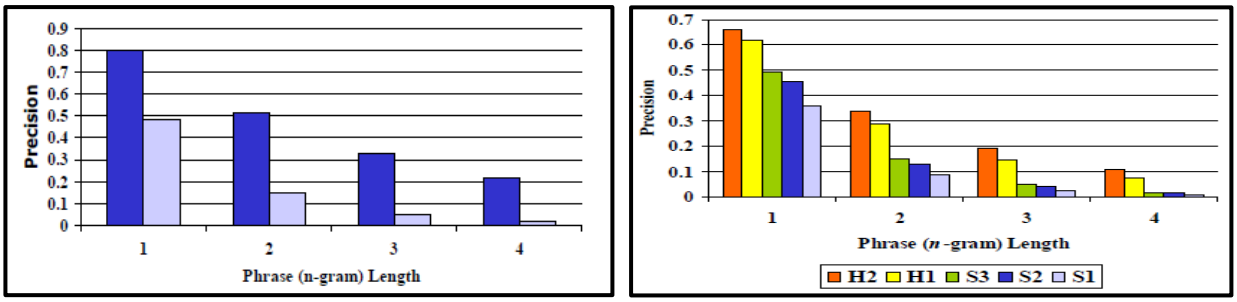


Figure 20 – (Left picture): Distinguishing human from machine
(Right Picture): Machine and human translations

https://www.aclweb.org/anthology/P02-1040.pdf

According to Figure 12, the strong signal differentiating human (high precision) from machine (low precision) is striking. The difference becomes stronger when passing from unigram precision to 4-gram precision.

2.10.5. Bilingual Evaluation Understandy (BLEU) - Details

First, computing the geometric[1] average of the modified *n*-gram precisions P_n , using *n*-gram up to length *N* and positive weights w_n summing to one. Next, the meaning of variable *c* is the length of the candidate translation. Also, there has the variable *r* that represent the effective reference corpus length.

$$BP = \begin{cases} 1 & if\ c > r \\ e^{(1-\frac{r}{c})} & if\ c \leq r \end{cases}$$

Equation 16 – BP = brevity penalty

Then,

$$BLEU = BP \cdot \exp\left(\sum_{n=1}^{N} w_n logp_n\right)$$

Equation 17 – formula of bilingual evaluation understandy

The ranking behavior is more immediately apparent in the log domain –

$$\log BLEU = \min\left(1 - \frac{r}{c}, 0\right) + \sum_{n=1}^{N} w_n logp_n$$

Equation 18 – accurate formula of bilingual evaluation understandy

[1] The geometric average is harsh if any of the modified precisions vanish, but this should be an extremely rare event in test corpora of reasonable size (for $N_{max} \leq 4$). Using with geometric average yields stronger correlation with human judgments than our best results using an arithmetic average.

2.10.6. Bilingual Evaluation Understandy - Evaluation

The bilingual evaluation understandy metric ranges from 0 to 1. Few translations are given a score of 1, unless they are the same as the reference translation. For this reason, even a human translator not necessarily score 1. It is important to note that if there have a lot of reference translations per sentence, than the score will be higher [11].

S1	S2	S3	H1	H2
0.0527	0.0829	0.0930	0.1934	0.2571

Table 1 – Bilingual evaluation understandy on 500 sentences

3. APPROACH

In our project, we have hypothesis that the results of Seq2Seq model for the Hebrew will be accurate as the results of Seq2Seq model for English, and that's why we want to use with Seq2Seq functionality. In terms of organization, we organized our model for bibles that written in Hebrew. The structure of Hebrew is different from English, because in English there have more letters than Hebrew, and the vocabulary size in English is bigger than the vocabulary size in Hebrew.

Our flow of the project should be as follow - collect full text of few bibles in Hebrew versions which be made publicly (the amount of bibles in Hebrew is fewer than in English), remove irregular verses and align by verse, select books from each testament as development data, test data, and training data, create Parallel files for selected source and target version pairings, add target version tokens to beginning of each source verse, learn sub words from Hebrew vocabulary using all versions training data, apply Hebrew vocabulary to parallel files, train sequence to sequence model on each dataset, find best checkpoint[1] for each model using development data, decode test set using best checkpoint[1], undo sub word vocabulary and tokenization on output, and finally evaluate result using bilingual evaluation understandy (BLEU).

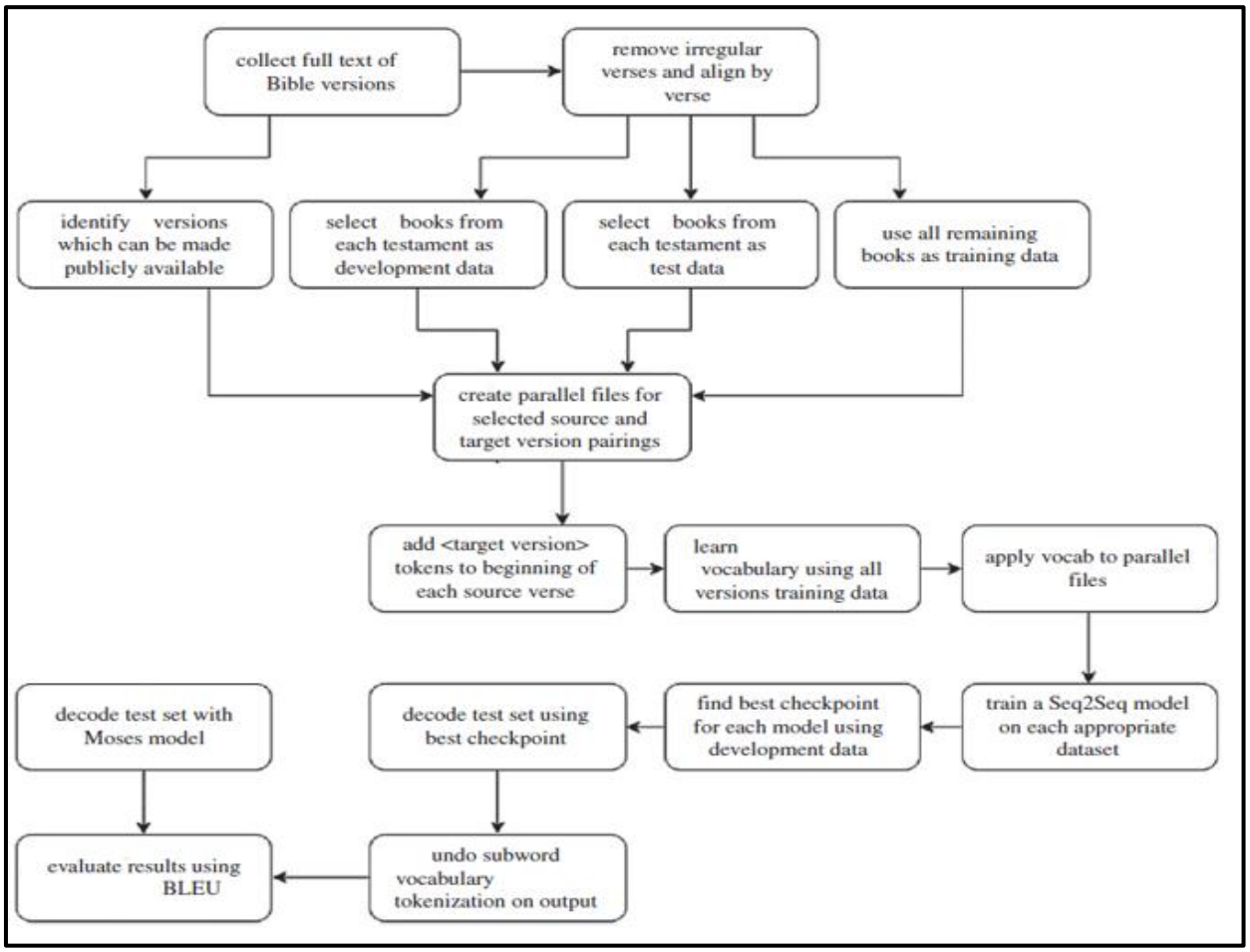


Figure 21 – Diagram of the project workflow
https://royalsocietypublishing.org/doi/pdf/10.1098/rsos.171920

[1] Models trained on smaller amounts of data tend to overfit faster. To ensure we have high-quality checkpoint we need to save them when we are training on smaller datasets. We saved a checkpoint every 5000 steps when we use multiple sources and multiple targets, and every 1000 steps when we use single target.

3.1. Architecture I

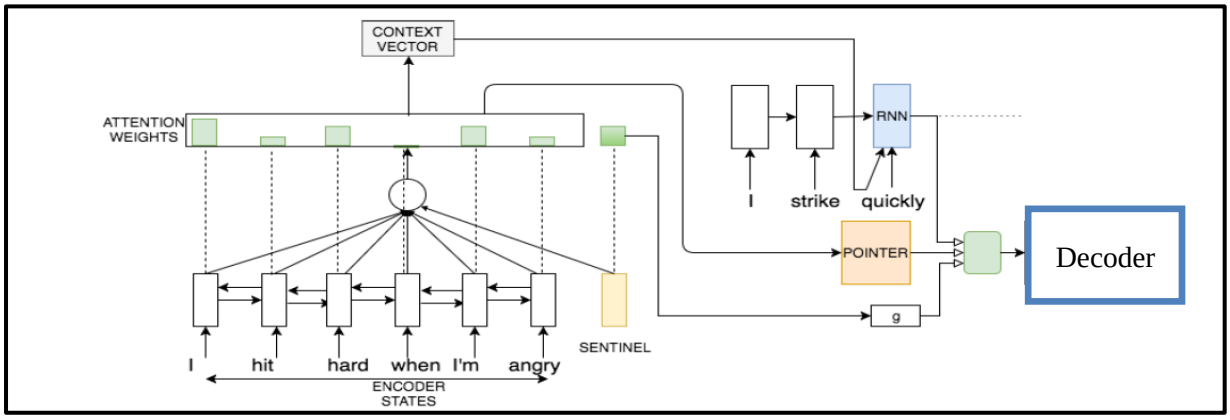


Figure 22 – Architecture I: Encoder-Decoder with attention module
https://aclweb.org/anthology/W17-4902

The first architecture option for our model. In this model, we use with bidirectional LSTM to encode the input. Our decoder side is a mixture model of RNN module and pointer network module. There have two individual modules that share the attentions weights over encoder states. The decoder RNN predicts probability distribution of next word over the vocabulary, while the pointer model predicts the probability distribution over words in input.

Attention weights are computed by decoder hidden state, encoder representations, and sentinel vector. Attention weights are shared by decoder RNN and pointer models. The final probability distribution over vocabulary derives from decoder RNN and pointer network.

3.1.1. Encoder Model

Let $LSTM_{enc}$ represent the forward encoder. h_t represent the hidden state of encoder model at step *t*. The following equations describe the model –

$$h^{enc}{}_0 = 0$$

Equation 19 – Hidden state of encoder model when t = 0

$$h^{enc}{}_t = LSTM_{enc}(h^{enc}{}_{t-1}, E_{enc}(x_t))$$

Equation 20 – Hidden state of encoder model at time t

3.1.2. Attention

$h^{dec}{}_t$ represent the hidden state of the decoder LSTM at step *t*. $E_{dec}(y_{t-1})$ represent the decoder side of the previous step output. First, we compute a query vector. The query vector is a linear transformation of $h^{dec}{}_{t-1}$. A sentinel vector *s* is concatenated with the encoder states to create F_{att}, where T_{enc} represents the number of tokens in encoder input sequence *x*. α^{norm} is a normalized attention weight vector. The value *g* represents the weight given to the decoder RNN module while computing output probabilities.

$$q = h^{enc}{}_{t-1} W_q$$

Equation 21 – query vector

$$F_{att} = cocncat(h^{enc}{}_{1,\dots,T_{enc}}, s)$$

Equation 22 – sentinel vector concatenated with encoder states

$$\alpha_i = \sum_{j=1}^{H} \tanh\left(F^{(ij)}{}_{att} q_j\right) + b_i$$

Equation 23 – attention weight vector

$$\alpha^{norm} = softmax(\alpha)$$

Equation 24 – Normalized attention weight

$$\beta = \alpha^{norm}{}_{1,2,..,T_{enc}}$$

Equation 25 – Normalized attention weight vector

$$g = \alpha^{norm}{}_{T_{enc}+1}$$

Equation 26 – Weight given to the decoder RNN module while computing output probabilities

3.1.3. Pointer Model

A pair of corresponding original and modern sentences have significant vocabulary overlap. There are lot of proper nouns and rare words which might not be predicted by a sequence to sequence model. Pointer networks have been used to enable copying of tokens from input directly [12]. The pointer models provide location-based attention, and output probability distribution. The formula of pointer network module can be expressed as –

$$P^{PTR}{}_t(w) = \sum_{x_j = w} (\beta_j)$$

Equation 27 – Pointer network module

3.1.4. Decoder Model

Summation of encoder states weighted by corresponding attention weights yields context vector. Output probabilities over vocabulary per decoder LSTM module are computes as follow –

$$c_t = \sum_{i=1}^{T_{enc}} \beta_i h^{enc}{}_i$$

Equation 28 – Summation of encoder states weighted by corresponding attention

$$h^{dec}{}_t = LSTM\left(h^{dec}{}_{t-1}, concat\left(E_{dec}(y_{t-1}, c_t)\right)\right)$$

Equation 29 – hidden state of decoder model at time t

$$P^{LSTM}{}_t = SOFTMAX\left(W_{out}\left(concat\left(h^{dec}{}_t, c_t\right)\right) + b^{out}\right)$$

Equation 30 – Probabilities over vocabulary per decoder LSTM module

3.1.5. Output Prediction

Output probability of a token *w* at step *t* is a weighted sum of probabilities from decoder LSTM model and pointer model given as follow –

$$P_t(w) = g \times P^{LSTM}{}_t(w) + (1 - g) \times P^{PTR}{}_t(w)$$

Equation 31 – Weighted sum of probabilities from decoder LSTM and pointer models

3.2. Architecture II

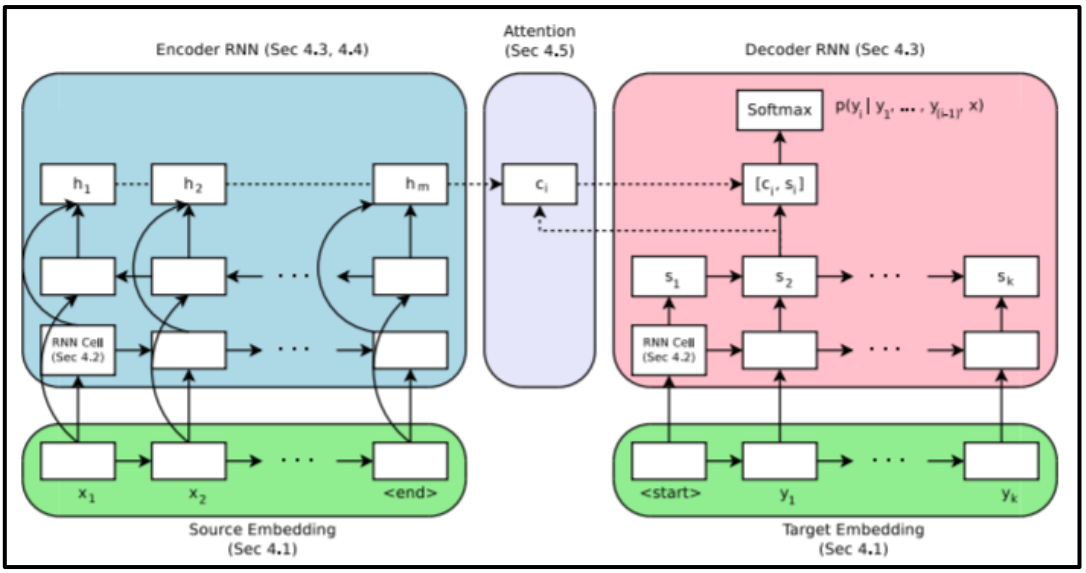


Figure 23 – Architecture II : Encoder-Decoder with attention module
https://www.aclweb.org/anthology/D17-1151

The second architecture option for our model. This model based on encoder-decoder with attention mechanism. An encoder function f_{enc} takes as input a sequence of source tokens $x = (x_1, \dots, x_m)$ and produces a sequence of states $h = (h_1, \dots, h_m)$.

The encoder function f_{enc} is bi-directional RNN and the state h_i produced by the backward and forward RNNs, $h_i = [\overrightarrow{h_i}, \overleftarrow{h_i}]$. The decoder f_{dec} is an RNN that predicts the probability of a target sequence $y = (y_1, \dots, y_n)$ based on the sequence of states h. The probability of each target token y_i is predicted based on the recurrent state in the decoder RNN s_i, the previous words $y_1, \dots, y_{i-1}$, and a context vector c_i [13].

There has another name to the context vector c_i. It's called the attention vector and is calculated as a weighted average of the source states.

$$c_i = \sum_j a_{ij} h_j \quad , \quad a_{ij} = \frac{\hat{a}_{ij}}{\sum_j \hat{a}_{ij}}$$

Equation 32 – Context vector

The attention function $att(s_i, h_j)$ calculates an unnormalized alignment score between the encoder state h_j and decoder state s_i.

$$\hat{a}_{ij} = att(s_i, h_j)$$

Equation 33 – Attention function

The decoder outputs are a distribution over a vocabulary of fixed size V :

$$P(y_i | y_1, \dots, y_{i-1}, x) = softmax(W[s_i, c_i] + b)$$

Equation 34 – Decoder output distribution

4. EXPECTED RESULT

Implementation of neural machine translation methods may yield near term improvements in style transfer, and we expect that our model treats this problem as a separate task. We want to use with corpus that include parallel data because it allows us to solve similarities, and differences in nuanced between all the versions of Hebrew bibles. We hope that this project inspires the creation of style transfer architecture for Hebrew bibles.

In our project, we want to use in the flow diagram as shown in 'Approach' section for Hebrew bibles. We expect that our model will transfer the source text in another form which is close to target model, and the results for Hebrew bibles will be accurate as the results for English bibles. Furthermore, we expect that sequence (Seq2Seq) model will make a lot of changes to the source sentences and achieves the highest BLEU score.

5. SOFTWARE ENGINEERING DOCUMENTATION

5.1. Use Case

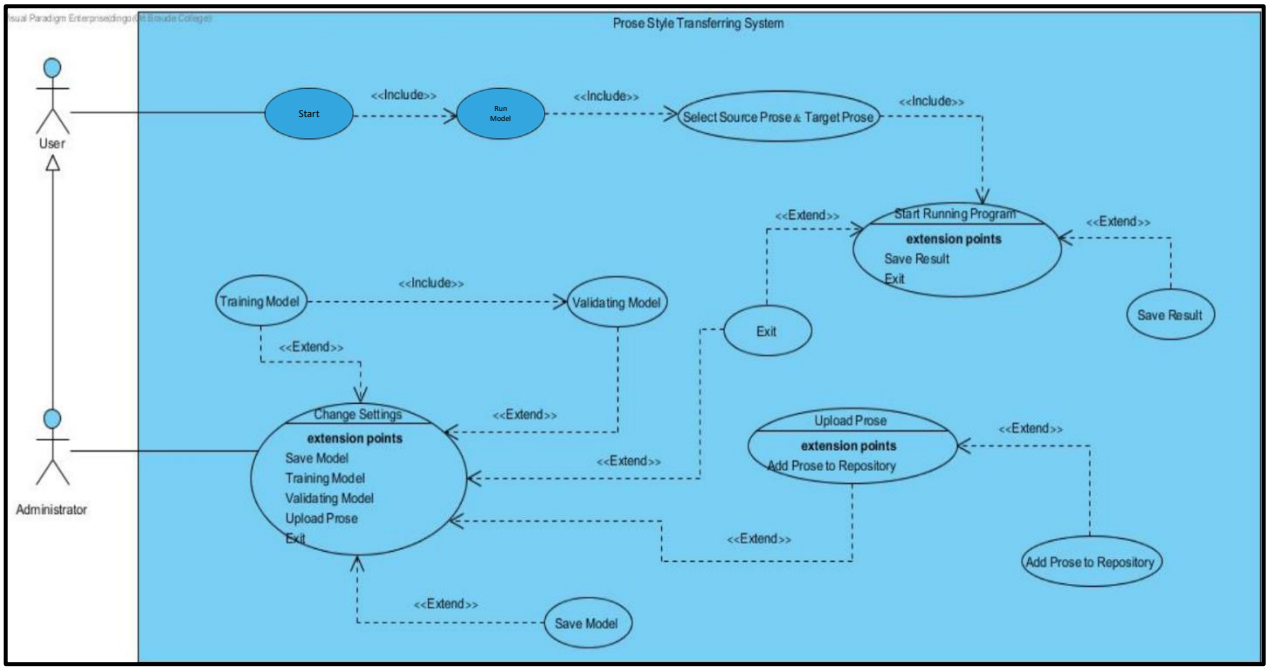


Figure 24 – Prose style transferring use case diagram

UC1: Make Compression -

- Goal - compression between source prose text to target prose text with Seq2Seq model.
- Precondition – choose role type.
- Possible error – select a corrupted source and target prose.
- Limitations – select a source and target prose from repository.

Actor	System
Click on "Start"	Verifying user select role
Click on "Run Model"	Open "Select Source & Target Versions" window

Select source prose , target prose	Open repository
Press "Start Running Program"	Calculate the output
	Collect the proses in the repository and append them to the main corpus
	Remove irregular verses and align by verse
	Split the main corpus to development, testament, and training data
	Create parallel files for selected source and target
	Add target version tokens to beginning of each source verse
	Learn 30000 sub words vocabulary using all versions training data
	Apply vocabulary to parallel files
	Train sequence to sequence model on each dataset
	Find best checkpoint for each model using development data
	Decode test set using best checkpoint
	Undo sub word vocabulary and tokenization on output
	Evaluate result using bilingual evaluation understandy (BLEU)
Click "Save" or "Exit"	Save / Exit
	If "Save" was clicked, saving output file that contains compressions between source and target proses in the user storage

Table 2 – UC1 Make Compression.

UC2: Change settings -

- Goal – change parameters that belongs to the model in the system.
- Precondition – administrator login success.
- Possible error – corrupted source and target prose.
- Limitations – change parameters according to the range limitations.

Actor	System
Click on "Start"	Verifying user select manager role
Click on "Settings"	Open "Setting" window
Change parameters that belongs to the model in the system	Finish saving the new parameters in the system and display message "saved successfully"

Table 3 – UC2 Change settings

5.2. Class Diagram

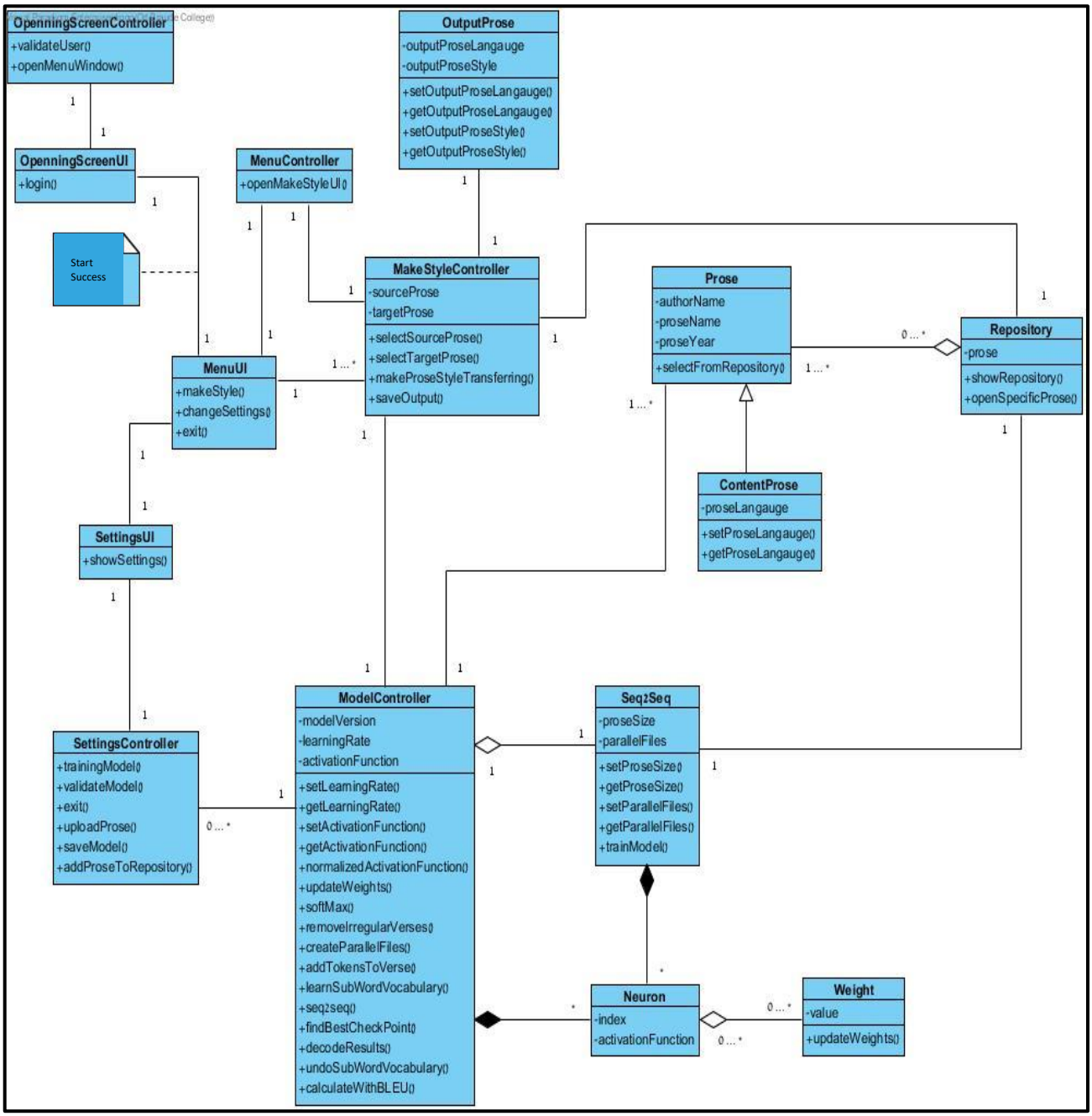


Figure 25 – Prose style transferring class diagram

5.3. Sequence Diagram

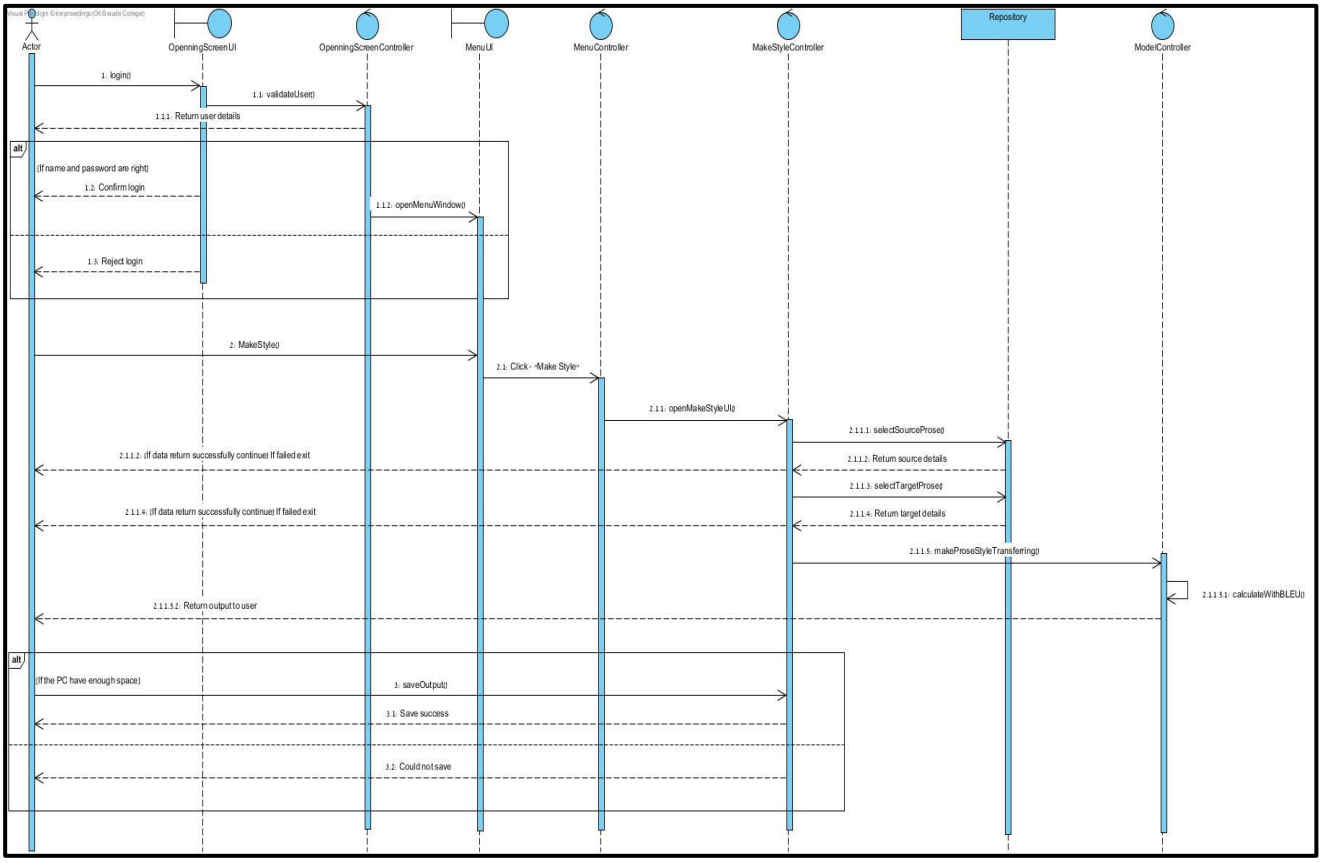


Figure 26 – Prose style transferring sequence diagram.

5.4. User Interface

5.4.1. Windows

Start window - The first window that the user sees when he opens the application. The user needs to select which role he wants to be in the system – regular user, manager. Also, the user can click on "Exit" button if he wants to exit from the program, and he can press on "Help" button if he wants to see explanations about the system, and this current window.

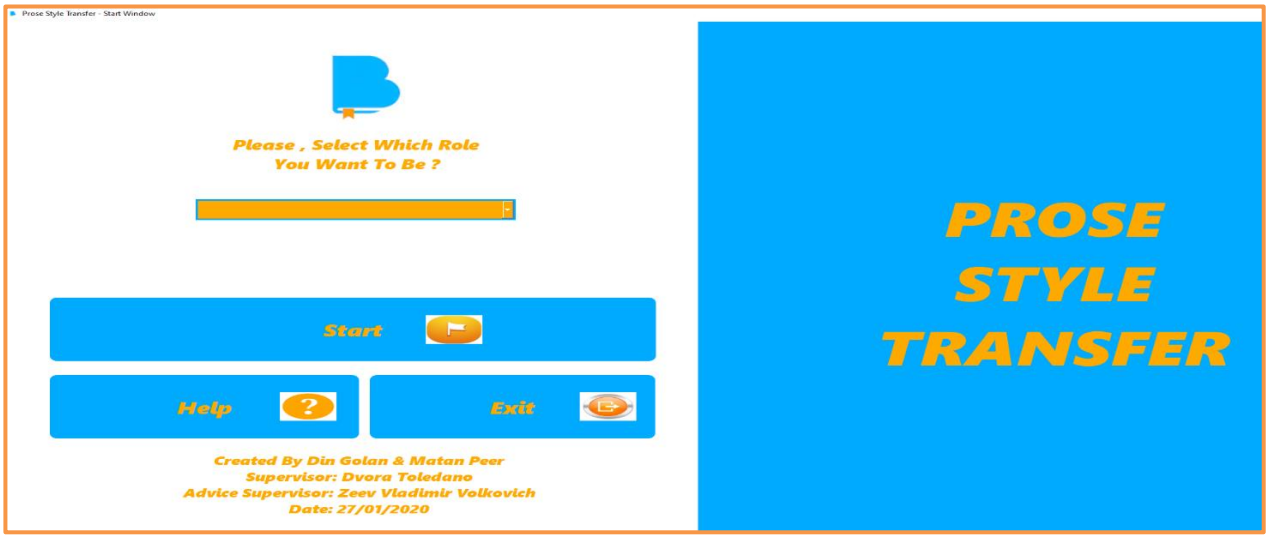


Figure 27 - Start window

User window - After the user decide to be regular user, the system display to him the window of regular user. In this window the user can run two types of model. First type is model without data augmentation, and second type is model with data augmentation. The differences between the models is the augmentations, it means change word to their synonyms. The model with data augmentations change the words to their synonyms, and the model without augmentations do not make these operations. Also, the user can click on "Back" button if he wants to return to previous window, and he can press on "Help" button if he wants to see explanations about the system, and this current window.

Figure 28 - Main window for regular user

Manager window – After the user decide to be manager, the system display to him the window of manager. In this window the manager can run two types of model like the regular user. It means that the operation of running model is similar to both roles. Also, the manager can click on "Settings" button and change some important parameters that belongs to the model. Furthermore, the manager can click on "Back" button if he wants to return to previous page, and he can click on "Help" button if he wants to see explanations about the system, and this current window.

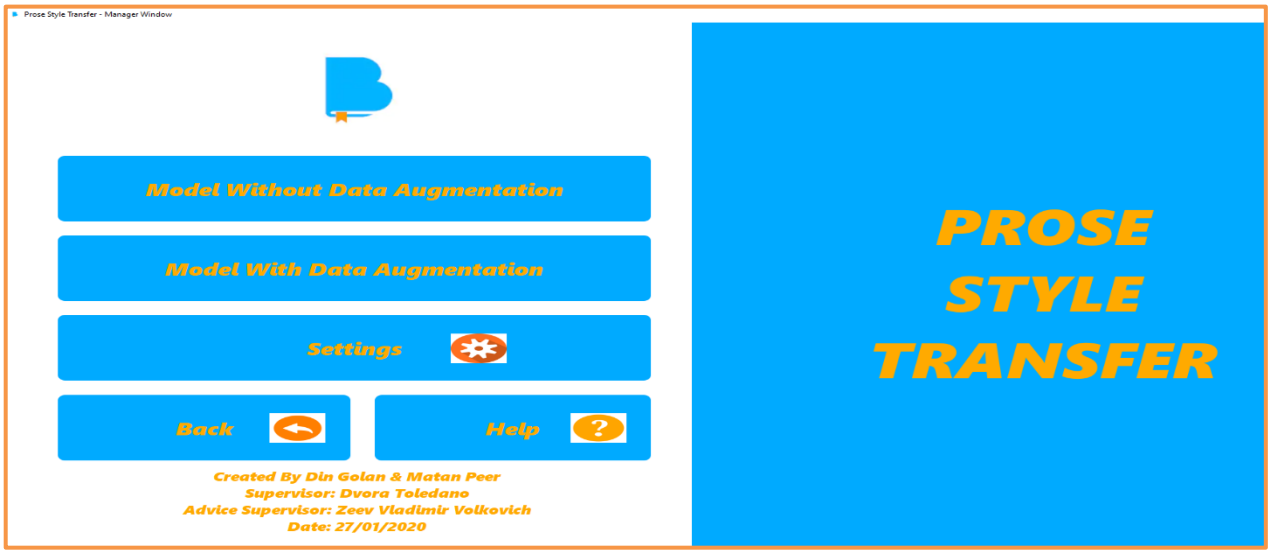


Figure 29 – Main window for manager user

Select source, target window – In this window the user / manager needs to select source and target prose. After the user / manager select his proses, he can run the model by click on “Run Model” button. Also, the user / manager can click on “Back” button if he wants to return to the previous page, and he can click on “Help” button if he wants to see explanations about the system, and this current window.

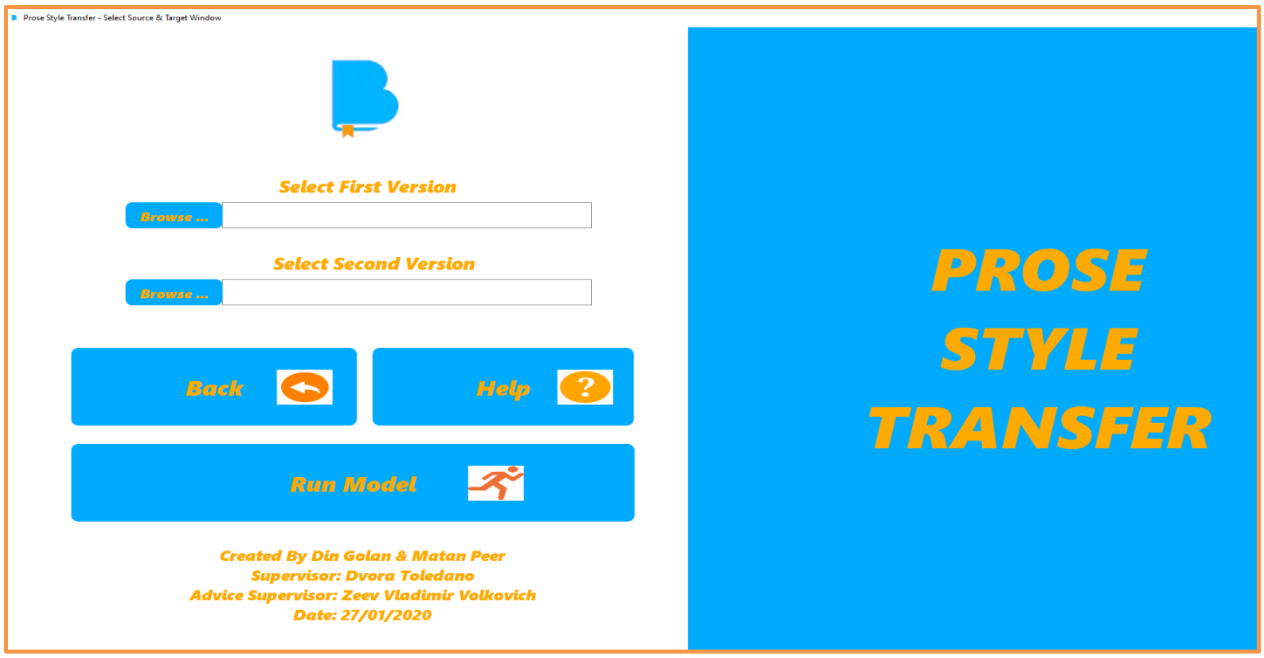


Figure 30 - Select source, target prose

The user / manager chooses source prose, and target prose from the repository and click on them, then he needs to click on the "Run Model" button.

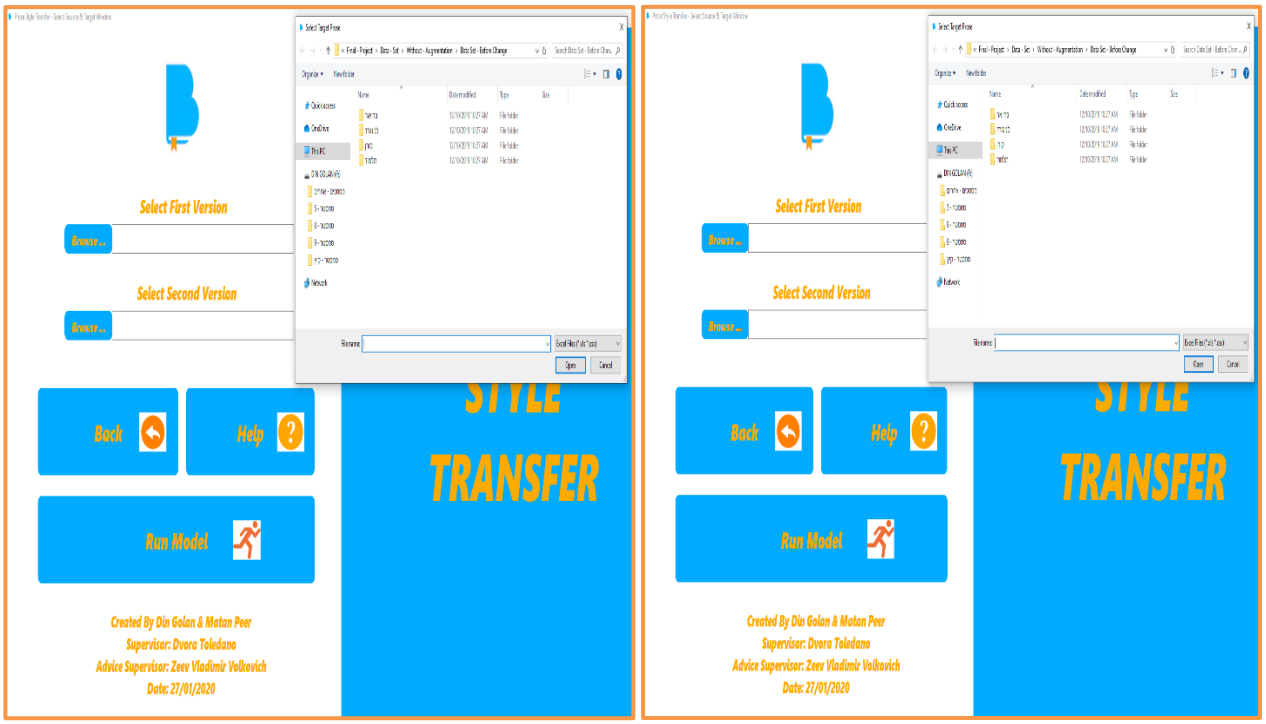


Figure 31 – (Left picture) the user / manager selects available source from repository, (Right picture) the user / manager selects target prose from repository

Settings window – This window is available only for the manager. The manager can change important settings that belongs to the model of the system. When the manager finish to fill his parameters, he can click on “Apply” button and then the settings will save in the system. Furthermore, if the manager clicks on “Apply” button before he starts to fill parameters, he will get message from the system if he wants to use with the default parameters of the system. Also, the manager can click on “Back” button if he wants to return to the previous page, and he can click on “Help” button if he wants to see explanations about the system, and this current window.

Figure 32 – Settings window for the manager

Progress window – In this window we have the prediction phase. After the user / manager selects his versions, he predicts his choices with the model of the system. The user / manager needs to wait until the process of the prediction will done. When the prediction process finished the user / manager will get message from the system that he can see the results of the model. Also, the user / manager can click on “Back” button if he wants to return to the previous page, and he can click on “Help” button if he wants to see explanations about the system, and this current window.

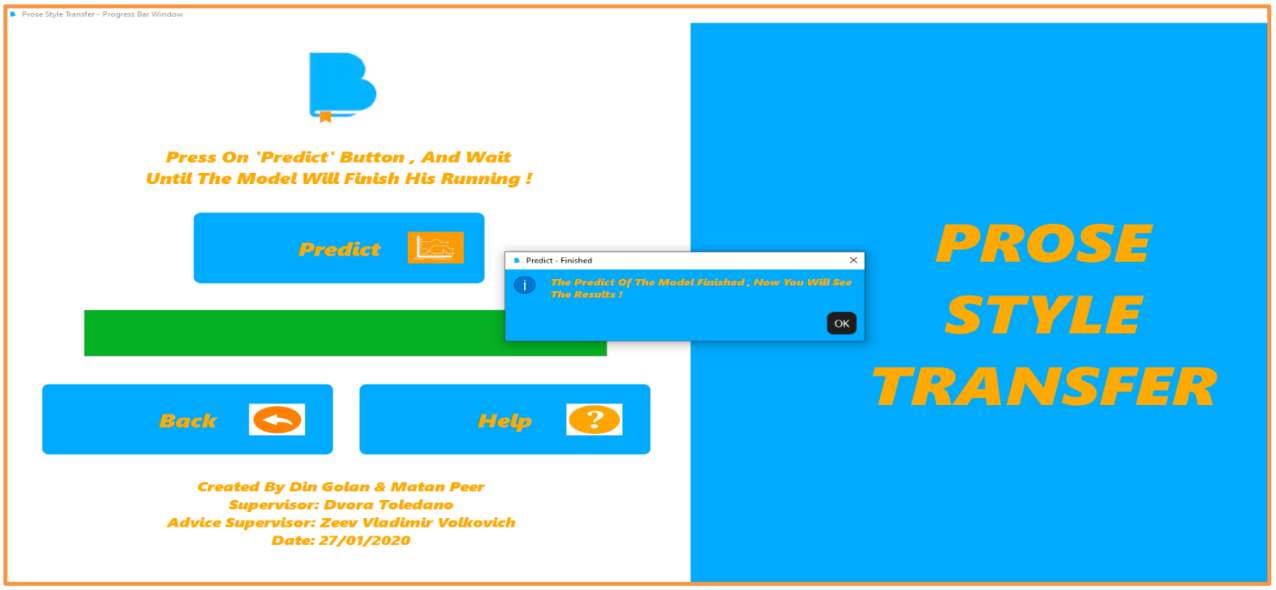


Figure 33 – Progress window for predict phase

Results window – The user / manager can see the results of the model. The result contains two main parts. The first part represents the accuracy between the first version and the second version that the user / manager selects. The second part represent in more details the compressions between sentences from both versions that the user / manager selects. Also, the user / manager can click on "Home" button if he wants to return to the home page, and he can click on "Help" button if he wants to see explanations about the system, and this current window. Important note – if the user is regular user and he press on "Home" button, he will come back to the "User window", and If the user is manager and he press on "Home" button, he will come back to the "Manager window".

Figure 34 – Results window, after the model finish his prediction for the versions that the user / manager selects

Create model window – Only the manager can create new model for the system. If we don't have any model in the system, the manager must create new one. If the manager wants to build new model, he needs to click on "Build Model" button. After the manager create new model, he will get a message that the model created successfully, and he can continue to the prediction phase. Also, the manager can click on "Back" button if he wants to return to the previous page, and he can click on "Help" button if he wants to see explanations about the system, and this current window.

Figure 35 – Build new model before we continue to the prediction phase

Histogram window – In this window the user / manager can see the results of the output excel as histogram. The results at the output excel consist accuracies between sentences from both versions that the user / manager select. The histogram window represent for the user / manager the results in another way, its mean in more comfortable way.

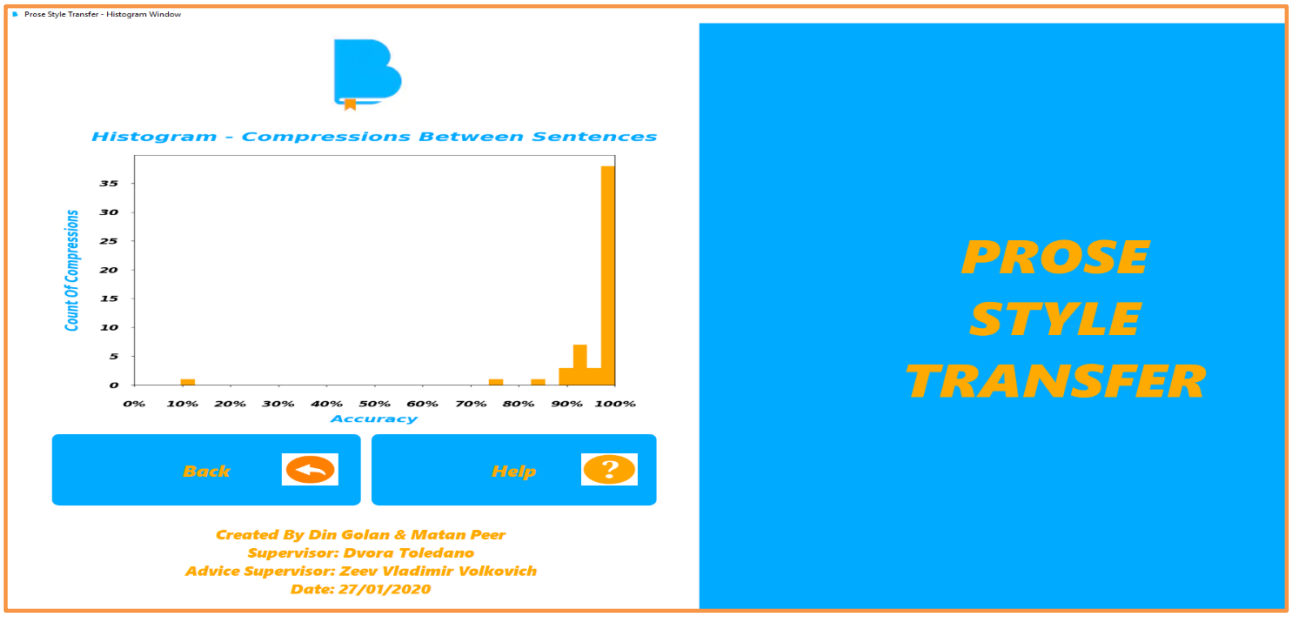


Figure 36 – Histogram window that represent in more comfortable way the accuracy between sentences that belongs to both versions that user / manager select

Help page – With the help page the user / manager can see all the instructions and explanations about the system. In each window, the user / manager can see explanations about each component and process in the system.

Figure 37 – Help page that explain to the user / manager about each component and scenario in the system

5.4.2. Errors and alerts

If the user does not select any role to be in the system –

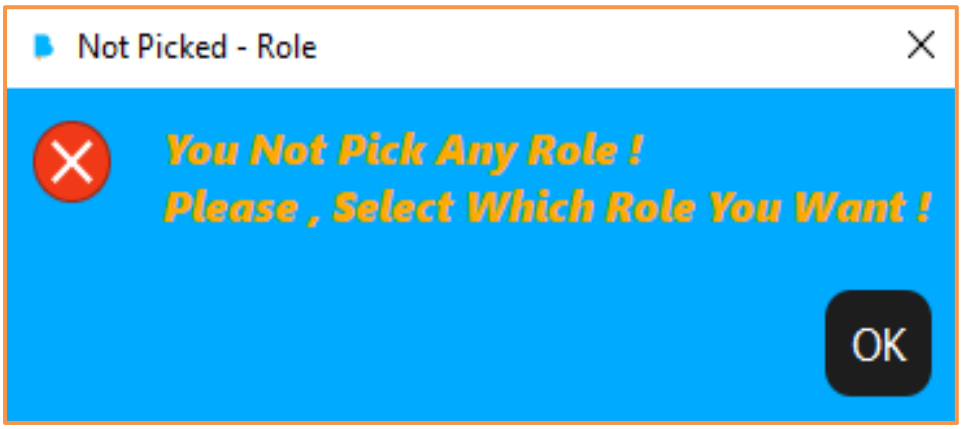


Figure 38 – The user does not select any role – error message

If the user / manager doesn't select prose to upload as source or target prose -

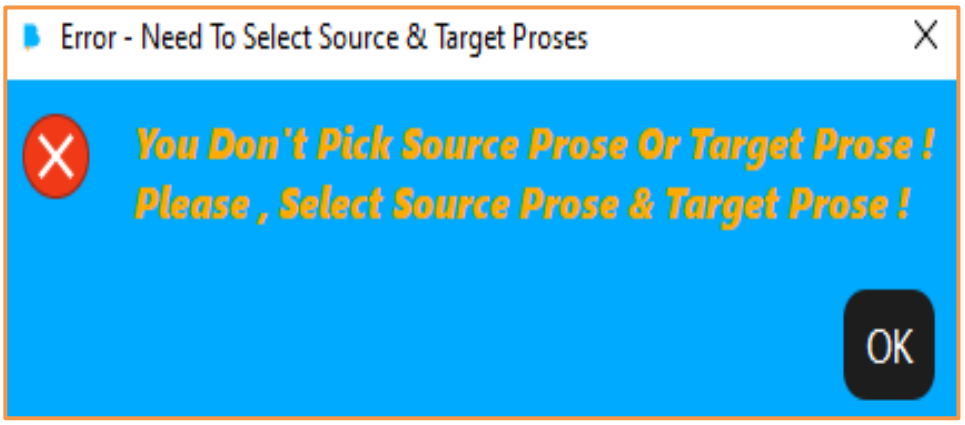


Figure 39 – The user doesn't choose prose to upload - error message

If the manager does not fill ant details at settings –

Figure 40 - Message for using in default settings of the system - warning message

If we have model in our system, the system will load it and send a message about that to the user –

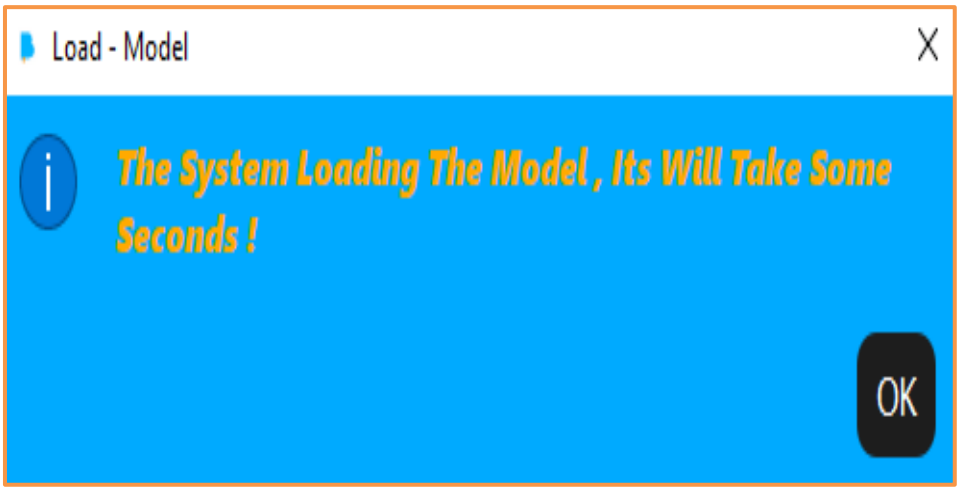


Figure 41 – The system loads the current model that exist in the system – information message

After the predict phase finish, the system will send a message about that to the user, because after this message the user can see the results of the model –

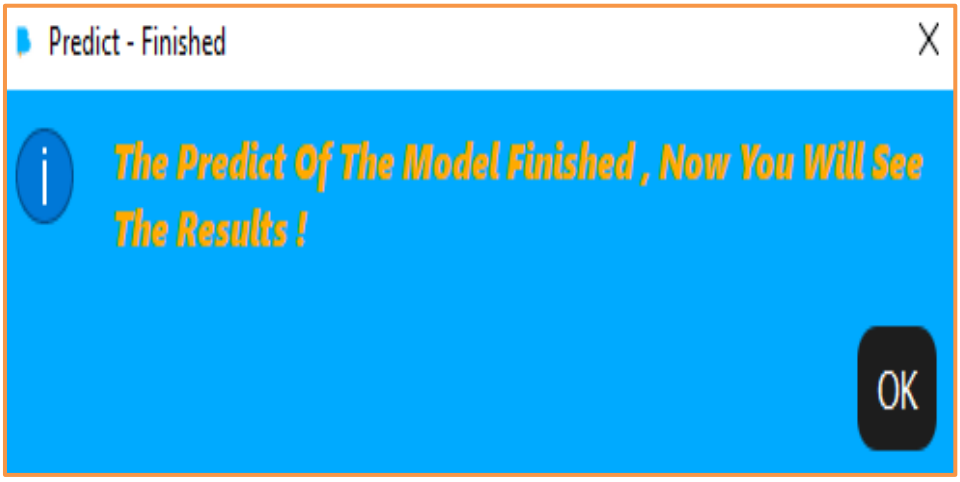


Figure 42 – The system sends that the prediction phase finished – information message

5.5. Testing Plan

Test name	Description	Expected result	Actual result
Corrupted prose	Upload corrupted prose which cannot be open	Error	Equal
Missed prose when click on “Cancel” in file dialog	Press “Cancel” without select any prose	Error	Equal
Missed prose when running the model	Pressed on "Run Model" without selecting source or target prose	Error	Equal
Go back to select source & target prose	Before prediction phase, the user wants to change his prose selecting	Open select source & target versions	Pass
Select prose that does not exist	On file dialog, select prose that does not exist in the repository of the system	Error	Equal
Go back to start window	From user window, click on “Back” and return to “Start” window	Open start window	Pass
Select role	Open combo box and select which role you want to be	Open user window or manager window	Pass
Not select role	Click on “Start” without selecting any role	Error	Equal
Exit from start window	On start window click on "Exit", and out from the system	Close start window	Pass
Save output results	When the output compressions between sentences created, save it to each folder you want	Path location in hard disk	Pass
Apply Settings	Fill settings details, and click on “Apply”	Pop-up window, new parameters saving successfully	Pass
Apply settings without filling any details	Click on “Apply” in settings window	Pop-up window, asking for using default settings	Pass

Table 4 – Testing plan

6. RESULTS AND CONCLUSIONS

6.1. Results

6.1.1. First example - model without augmentation and with default parameters

Max - Accuracy	במדבר א, א - לדינגרד	במדבר א, א - ברייאר
0.856959462	וידבר יהוה אל־משה במדבר סיני באוהל מועד באחד לחדש השני בשנה השנית לצאתם מארץ מצרים לאמר:	וידבר יהוה אל־משה במדבר סיני באוהל מועד באחד לחדש השני בשנה השנית לצאתם מארץ מצרים לאמר:
0.925797224	שאו את־ראש כל־עדת בני־ישראל למשפחתם לבית אבתם במספר שמות כל־זכר לגלגלתם:	שאו את־ראש כל־עדת בני־ישראל למשפחתם לבית אבתם במספר שמות כל־זכר לגלגלתם:
0.882715583	מבן עשרים שנה ומעלה כל־יצא צבא בישראל תפקדו אתם לצבאתם אתה ואהרן:	מבן עשרים שנה ומעלה כל־יצא צבא בישראל תפקדו אתם לצבאתם אתה ואהרן:
0.981796917	ואתכם יהיו איש איש למטה איש ראש לבית אבתיו הוא:	ואתכם יהיו איש איש למטה איש ראש לבית אבתיו הוא:
0.958375692	ואלה שמות האנשים אשר יעמדו אתכם לראובן אלישור בן־שדיאור:	ואלה שמות האנשים אשר יעמדו אתכם לראובן אלישור בן־שדיאור:
0.994161665	לשמעון שלומיאל בן־צורישדי:	לשמעון שלומיאל בן־צורישדי:
0.993910313	ליהודה נחשון בן־עמינדב:	ליהודה נחשון בן־עמינדב:
0.995596895	ליששכר נתנאל בן־צוער:	ליששכר נתנאל בן־צוער:
0.992136717	לזבולן אליאב בן־חלן:	לזבולן אליאב בן־חלן:
0.938210249	לבני יוסף לאפרים אלישמע בן־עמיהוד למנשה גמליאל בן־פדהצור:	לבני יוסף לאפרים אלישמע בן־עמיהוד למנשה גמליאל בן־פדהצור:
0.979751408	לבנימן אבידן בן־גדעוני:	לבנימן אבידן בן־גדעוני:
0.996687114	לדן אחיעזר בן־עמישדי:	לדן אחיעזר בן־עמישדי:
0.98426038	לאשר פגיעיאל בן־עכרן:	לאשר פגיעיאל בן־עכרן:
0.995931089	לגד אליסף בן־דעואל:	לגד אליסף בן־דעואל:
0.839537382	לנפתלי אחירע בן־עינן:	לנפתלי אחירע בן־עינן:
0.997864783	אלה קראי (ק) העדה נשיאי מטות אבתם ראשי אלפי ישראל הם:	אלה קראי (ק) העדה נשיאי מטות אבתם ראשי אלפי ישראל הם:
0.850886117	ויקח משה ואהרן את האנשים האלה אשר נקבו בשמות:	ויקח משה ואהרן את האנשים האלה אשר נקבו בשמות:
0.956107914	ואת כל־העדה הקהילו באחד לחדש השני ויתילדו על־משפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה לגלגלתם:	ואת כל־העדה הקהילו באחד לחדש השני ויתילדו על־משפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה לגלגלתם:
0.886400104	כאשר צוה יהוה את־משה ויפקדם במדבר סיני: ס	כאשר צוה יהוה את־משה ויפקדם במדבר סיני: ס
0.958353162	ויהיו בני־ראובן בכר ישראל תולדתם למשפחתם לבית אבתם במספר שמות לגלגלתם כל־זכר מבן עשרים שנה ומעלה כל יצא צבא:	ויהיו בני־ראובן בכר ישראל תולדתם למשפחתם לבית אבתם במספר שמות לגלגלתם כל־זכר מבן עשרים שנה ומעלה כל יצא צבא:
0.914564013	פקדיהם למטה ראובן ששה וארבעים אלף וחמש מאות: ס	פקדיהם למטה ראובן ששה וארבעים אלף וחמש מאות: ס
0.856680532	לבני שמעון תולדתם למשפחתם לבית אבתם מפקדיו במספר שמות לגלגלתם כל־זכר מבן עשרים שנה ומעלה כל יצא צבא:	לבני שמעון תולדתם למשפחתם לבית אבתם מפקדיו במספר שמות לגלגלתם כל־זכר מבן עשרים שנה ומעלה כל יצא צבא:
0.908762634	פקדיהם למטה שמעון תשעה ושלשים אלף וחמש מאות: ס	פקדיהם למטה שמעון תשעה וחמשים אלף ושלש מאות: ס
0.91680181	לבני גד תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	לבני גד תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.862553775	פקדיהם למטה גד חמשה וארבעים אלף ושש מאות וחמשים: ס	פקדיהם למטה גד חמשה וארבעים אלף ושש מאות וחמשים: ס
0.929282486	לבני יהודה תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	לבני דן תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.897342563	פקדיהם למטה יהודה ארבעה ושבעים אלף ושש מאות: ס	פקדיהם למטה יהודה ארבעה ושבעים אלף ושש מאות: ס
0.851397216	לבני יששכר תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	לבני יששכר תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.838941693	פקדיהם למטה יששכר ארבעה וחמשים אלף ומאתים: ס	פקדיהם למטה יששכר ארבעה וחמשים אלף וארבע מאות: ס
0.968332112	לבני זבולן תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	לבני זבולן תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.98854661	פקדיהם למטה זבולן שבעה וחמשים אלף וארבע מאות: ס	פקדיהם למטה זבולן שבעה וחמשים אלף וארבע מאות: ס
0.97457099	לבני יוסף לבני אפרים תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	לבני יוסף לבני אפרים תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.956302822	פקדיהם למטה אפרים ארבעים אלף וחמש מאות: ס	פקדיהם למטה אפרים ארבעים אלף וחמש מאות: ס
0.950689316	לבני מנשה תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	לבני מנשה תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.986346543	פקדיהם למטה מנשה שנים ושלשים אלף ומאתים: ס	פקדיהם למטה מנשה שנים ושלשים אלף ומאתים: ס
0.875587365	לבני בנימן תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	לבני בנימן תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.911822557	פקדיהם למטה בנימן חמשה ושלשים אלף וארבע מאות: ס	פקדיהם למטה בנימן חמשה ושלשים אלף וארבע מאות: ס
0.864256918	לבני דן תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	לבני בנימן תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.945149064	פקדיהם למטה דן שנים וששים אלף ושבע מאות: ס	פקדיהם למטה דן שנים וששים אלף ושבע מאות: ס
0.952512145	לבני אשר תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	לבני אשר תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.990902584	פקדיהם למטה אשר אחד וארבעים אלף וחמש מאות: ס	פקדיהם למטה אשר אחד וארבעים אלף וחמש מאות: ס
0.844710171	בני נפתלי תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:	בני נפתלי תולדתם למשפחתם לבית אבתם במספר שמות מבן עשרים שנה ומעלה כל יצא צבא:
0.970913231	פקדיהם למטה נפתלי שלשה וחמשים אלף וארבע מאות: ס	פקדיהם למטה נפתלי שלשה וחמשים אלף וארבע מאות: ס
0.914273441	אלה הפקדים אשר פקד משה ואהרן ונשיאי ישראל שנים עשר איש איש־אחד לבית־אבתיו היו:	אלה הפקדים אשר פקד משה ואהרן ונשיאי ישראל שנים עשר איש איש־אחד לבית־אבתיו היו:
0.936853945	ויהיו כל־פקדי בני־ישראל לבית אבתם מבן עשרים שנה ומעלה כל־יצא צבא בישראל:	ויהיו כל־פקדי בני־ישראל לבית אבתם מבן עשרים שנה ומעלה כל־יצא צבא בישראל:
0.85489434	ויהיו כל־הפקדים ששׁ־מאות אלף ושלשת אלפים וחמש מאות וחמשים:	ויהיו כל־הפקדים ששׁ־מאות אלף ושלשת אלפים וחמש מאות וחמשים:
0.920121312	והלוים למטה אבתם לא התפקדו בתוכם: ס	והלוים למטה אבתם לא התפקדו בתוכם: ס
0.995207608	וידבר יהוה אל־משה לאמר:	וידבר יהוה אל־משה לאמר:
0.894885361	אך את־מטה לוי לא תפקד ואת־ראשם לא תשא בתוך בני ישראל:	אך את־מטה לוי לא תפקד ואת־ראשם לא תשא בתוך בני ישראל:
0.971207976	ואתה הפקד את־הלוים על־משכן העדות ועל כל־כליו ועל כל־אשר־לו המה ישאו את־המשכן ואת־כל־כליו והם ישרתהו וסביב למשכן יחנו:	ואתה הפקד את־הלוים על־משכן העדות ועל כל־כליו ועל כל־אשר־לו המה ישאו את־המשכן ואת־כל־כליו והם ישרתהו וסביב למשכן יחנו:
0.981173337	ובנסע המשכן יורידו אהן הלוים ובחנת המשכן יקימו אהן הלוים והזר הקרב יומת:	ובנסע המשכן יורידו אהן הלוים ובחנת המשכן יקימו אהן הלוים והזר הקרב יומת:
0.950103045	ויחנו בני ישראל איש על־מחנהו ואיש על־דגלו לצבאותם:	ויחנו בני ישראל איש על־מחנהו ואיש על־דגלו לצבאותם:
0.987280548	והלוים יחנו סביב למשכן העדות ולא־יהיה קצף על־עדת בני ישראל ושמרו הלוים את־משמרת משכן העדות:	והלוים יחנו סביב למשכן העדות ולא־יהיה קצף על־עדת בני ישראל ושמרו הלוים את־משמרת משכן העדות:
0.933521164	ויעשו בני־ישראל ככל אשר צוה יהוה את־משה כן עשו: ס	ויעשו בני־ישראל ככל אשר צוה יהוה את־משה כן עשו: ס

Figure 43 – Output results between two bibles versions that the user / manager selects

Figure 44 – Results window

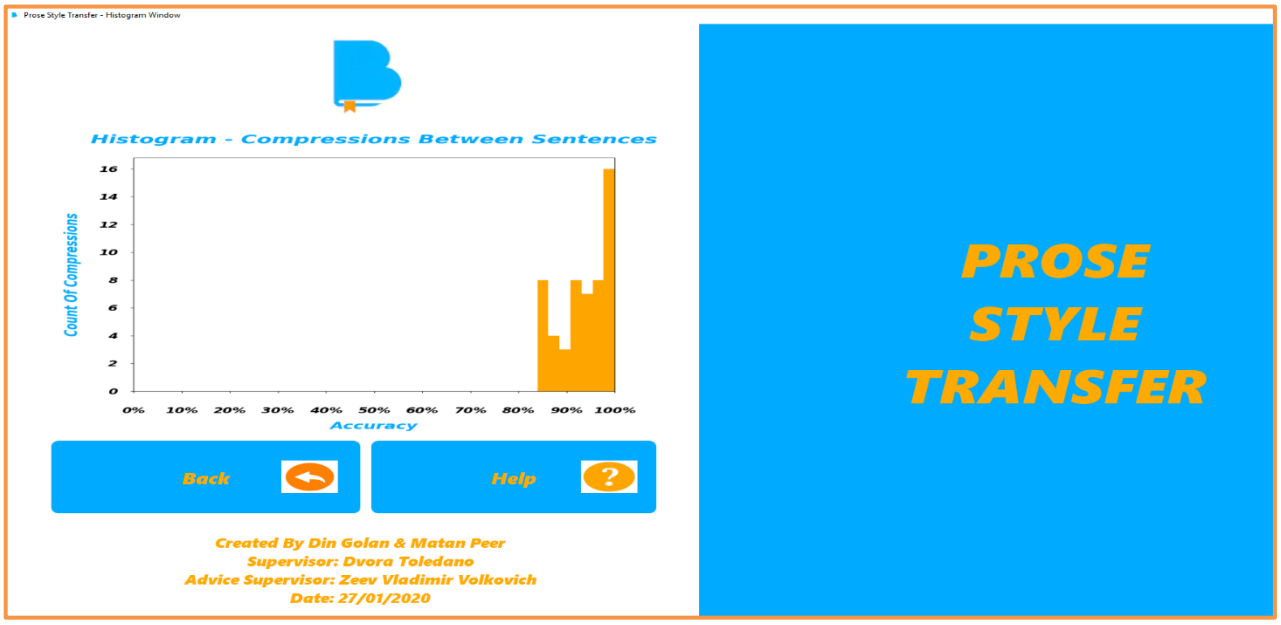


Figure 45 – Histogram window that represent in more comfortable way the results

In this experiment we take two different bible versions and compare between them by the model of our system. The model does not use with data augmentation, its mean that he does not take some words from each version and replace them by their synonyms.

In this output result we see in more details the accuracy between sentences according to the prediction phase of the model. The prediction phase creates values of accuracy between 0 to 100. Also, the user / manager can see the results as histogram.

The parameters of the model in this example is: epochs number – 10, batch size – 64, training split – 0.7. Those parameters are default parameters of the system. Note - only the manager can change the parameters of the model in the system.

For summary, in this example the accuracy between the versions is approximately 67% according to the model without data augmentation.

6.1.2. Second example – model with augmentation and with default parameters

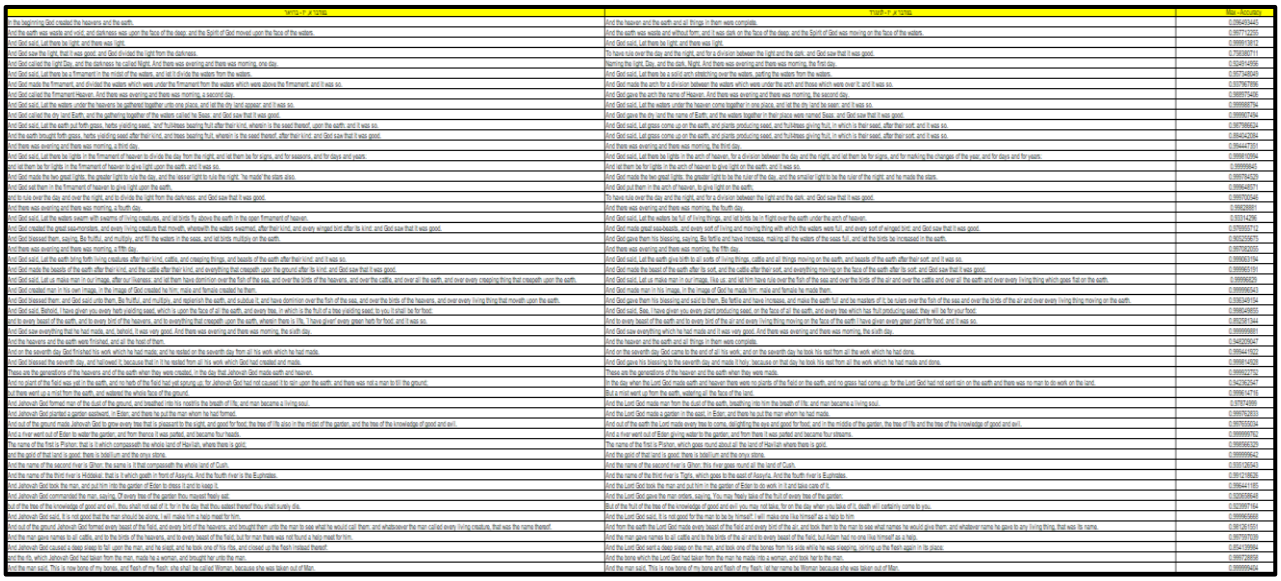


Figure 46 – Output results between two bibles versions that the user / manager selects

Figure 47 – Results window

Figure 48 – Histogram window that represent in more comfortable way the results

In this experiment we take two different bible versions and compare between them by the model of our system. The model use with data augmentation, its mean that he takes some words from each version and replace them by their synonyms. This operation of changing word to her synonym effects on the accuracy of the compression, its mean that the accuracy can be lower than compression between versions without data augmentation, or it can be higher.

In this output result we see in more details the accuracy between sentences according to the prediction phase of the model. The prediction phase creates values of accuracy between 0 to 100. Also, the user / manager can see the results as histogram.

The parameters of the model in this example is: epochs number – 10, batch size – 64, training split – 0.7. Those parameters are default parameters of the system. Note - only the manager can change the parameters of the model in the system.

For summary, in this example the accuracy between the versions is approximately 55% according to the model with data augmentation.

6.1.3. Compression between first and second examples

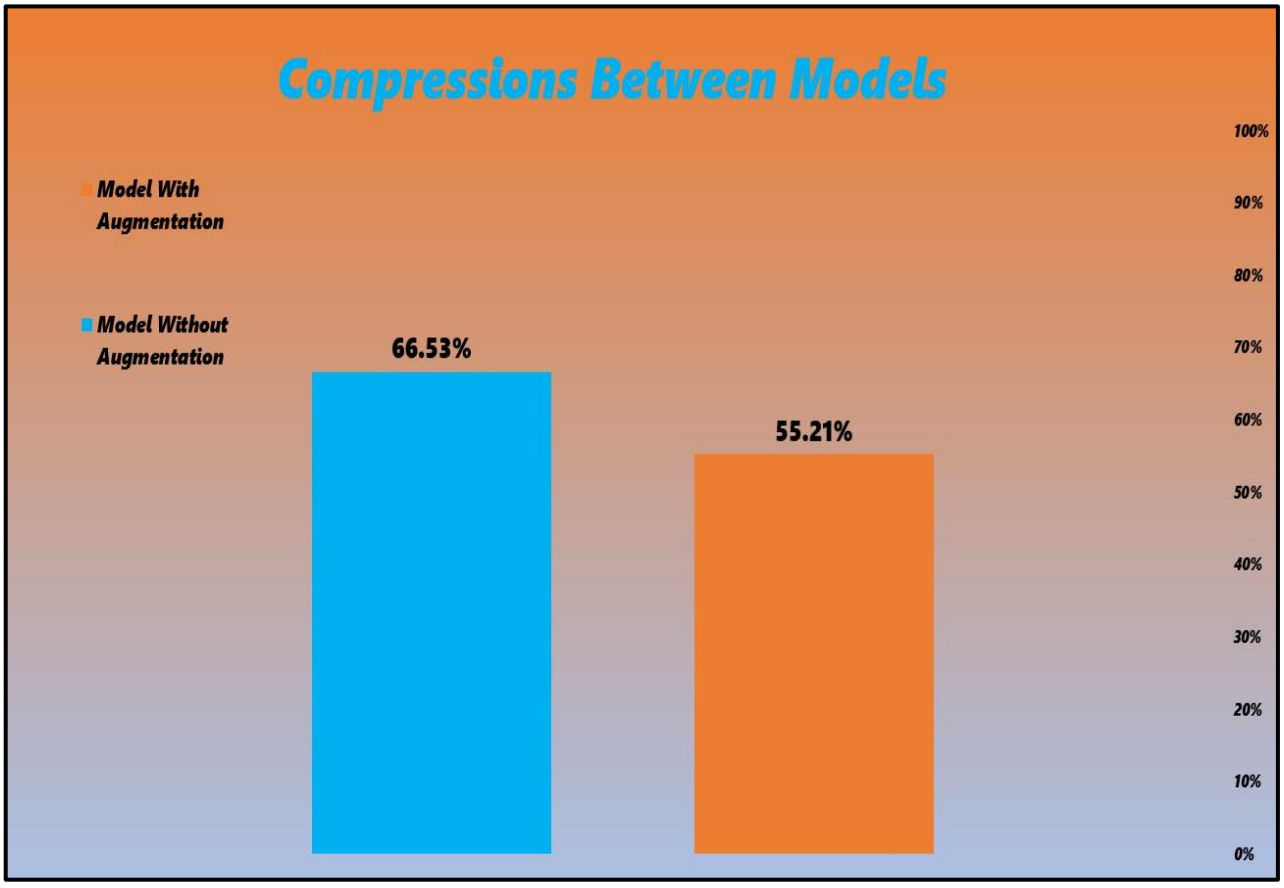


Figure 49 – Compression between model without data augmentation and model with data augmentation

6.1.4. Third example – model without augmentation and without default parameters

במדבר ז, פסוקים - ז , כג - ברואר	במדבר ז, פסוקים - ז , כג - לנינגרד	Max - Accuracy
ויהי ביום כלות משה להקים את־המשכן וימשח אתו ויקדש אתו ואת־כל־כליו ואת־המזבח ואת־כל־כליו וימשחם ויקדש אתם:	ויהי ביום כלות משה להקים את־המשכן וימשח אתו ויקדש אתו ואת־כל־כליו ואת־המזבח ואת־כל־כליו וימשחם ויקדש אתם:	0.989003718
ויקריבו נשיאי ישראל ראשי בית אבתם הם נשיאי המטת הם העמדים על־הפקדים:	ויקריבו נשיאי ישראל ראשי בית אבתם הם נשיאי המטת הם העמדים על־הפקדים:	0.97497952
ויביאו את־קרבנם לפני יהוה שש־עגלת צב ושני עשר בקר עגלה על־שני הנשאים ושור לאחד ויקריבו אותם לפני המשכן:	ויביאו את־קרבנם לפני יהוה שש־עגלת צב ושני עשר בקר עגלה על־שני הנשאים ושור לאחד ויקריבו אותם לפני המשכן:	0.916129053
ויאמר יהוה אל־משה לאמר:	ויאמר יהוה אל־משה לאמר:	0.979325891
קח מאתם והיו לעבד את־עבדת אהל מועד ונתתה אותם אל־הלוים איש כפי עבדתו:	קח מאתם והיו לעבד את־עבדת אהל מועד ונתתה אותם אל־הלוים איש כפי עבדתו:	0.947635114
ויקח משה את־העגלת ואת־הבקר ויתן אותם אל־הלוים:	ויקח משה את־העגלת ואת־הבקר ויתן אותם אל־הלוים:	0.951315939
את ׀ שתי העגלות ואת ארבעת הבקר נתן לבני גרשון כפי עבדתם:	את ׀ שתי העגלת ואת ארבעת הבקר נתן לבני גרשון כפי עבדתם:	0.276712
ואת ׀ ארבע העגלת ואת שמנת הבקר נתן לבני מררי כפי עבדתם ביד איתמר בן־אהרן הכהן:	ואת ׀ ארבע העגלת ואת שמנת הבקר נתן לבני מררי כפי עבדתם ביד איתמר בן־אהרן הכהן:	0.992901504
ולבני קהת לא נתן כי־עבדת הקדש עלהם בכתף ישאו:	ולבני קהת לא נתן כי־עבדת הקדש עלהם בכתף ישאו:	0.940172553
ויקריבו הנשאים את חנכת המזבח ביום המשח אתו ויקריבו הנשיאם את־קרבנם לפני המזבח:	ויקריבו הנשאים את חנכת המזבח ביום המשח אתו ויקריבו הנשיאם את־קרבנם לפני המזבח:	0.906868041
ויאמר יהוה אל־משה נשיא אחד ליום נשיא אחד ליום יקריבו את־קרבנם לחנכת המזבח: ס	ויאמר יהוה אל־משה נשיא אחד ליום נשיא אחד ליום יקריבו את־קרבנם לחנכת המזבח: ס	0.982526302
ויהי המקריב ביום הראשון את־קרבנו נחשון בן־עמינדב למטה יהודה:	ויהי המקריב ביום הראשון את־קרבנו נחשון בן־עמינדב למטה יהודה:	0.964533746
וקרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	וקרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	0.960925996
כף אחת עשרה זהב מלאה קטרת:	כף אחת עשרה זהב מלאה קטרת:	0.997039199
פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	0.99352622
שעיר־עזים אחד לחטאת:	שעיר־עזים אחד לחטאת:	0.996737778
ולזבח השלמים בקר שנים אילם חמשה עתודים חמשה כבשים בני־שנה חמשה זה קרבן נחשון בן־עמינדב: פ	ולזבח השלמים בקר שנים אילם חמשה עתודים חמשה כבשים בני־שנה חמשה זה קרבן נחשון בן־עמינדב: פ	0.968047857
ביום השני הקריב נתנאל בן־צוער נשיא יששכר:	ביום השני הקריב נתנאל בן־צוער נשיא יששכר:	0.990752697
הקרב את־קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	הקרב את־קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	0.96918273
כף אחת עשרה זהב מלאה קטרת:	כף אחת עשרה זהב מלאה קטרת:	0.997925997
פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	0.992183864
שעיר־עזים אחד לחטאת:	שעיר־עזים אחד לחטאת:	0.998199582
ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן נתנאל בן־צוער: פ	ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן אליצור בן־שדיאור: פ	0.644247055
ביום השלישי נשיא לבני זבולן אליאב בן־חלן:	ביום השלישי נשיא לבני זבולן אליאב בן־חלן:	0.886066437
קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	0.99732095
כף אחת עשרה זהב מלאה קטרת:	כף אחת עשרה זהב מלאה קטרת:	0.994382143
פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	0.99285382
שעיר־עזים אחד לחטאת:	שעיר־עזים אחד לחטאת:	0.999564707
ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן אליאב בן־חלן: פ	ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן אליאב בן־חלן: פ	0.874162555
ביום הרביעי נשיא לבני ראובן אליצור בן־שדיאור:	ביום הרביעי נשיא לבני ראובן אליצור בן־שדיאור:	0.997326612
קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	0.990405738
כף אחת עשרה זהב מלאה קטרת :	כף אחת עשרה זהב מלאה קטרת :	0.987595677
פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	0.998361647
שעיר־עזים אחד לחטאת:	שעיר־עזים אחד לחטאת:	0.999564707
ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן אליצור בן־שדיאור: פ	ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן אליצור בן־שדיאור: פ	0.900744379
ביום החמישי נשיא לבני שמעון שלמיאל בן־צורישדי:	ביום החמישי נשיא לבני שמעון שלמיאל בן־צורישדי:	0.99649328
קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	0.9829579
כף אחת עשרה זהב מלאה קטרת:	כף אחת עשרה זהב מלאה קטרת:	0.994382143
פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	0.998361647
שעיר־עזים אחד לחטאת :	שעיר־עזים אחד לחטאת :	0.982339442
ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן שלמיאל בן־צורישדי: פ	ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן שלמיאל בן־צורישדי: פ	0.950869977
ביום הששי נשיא לבני גד אליסף בן־דעואל:	ביום הששי נשיא לבני גד אליסף בן־דעואל:	0.984134734
קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	0.9829579
כף אחת עשרה זהב מלאה קטרת:	כף אחת עשרה זהב מלאה קטרת:	0.990257382
פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	0.998361647
שעיר־עזים אחד לחטאת:	שעיר־עזים אחד לחטאת:	0.998059213
ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן אליסף בן־דעואל: פ	ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן אליסף בן־דעואל: פ	0.915887475
ביום השביעי נשיא לבני אפרים אלישמע בן־עמיהוד:	ביום השביעי נשיא לבני אפרים אלישמע בן־עמיהוד:	0.984561861
קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה:	0.946126819
כף אחת עשרה זהב מלאה קטרת:	כף אחת עשרה זהב מלאה קטרת:	0.992877066
פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	0.998361647
שעיר־עזים אחד לחטאת:	שעיר־עזים אחד לחטאת:	0.998059213
ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן אלישמע בן־עמיהוד: פ	ולזבח השלמים בקר שנים אילם חמשה עתדים חמשה כבשים בני־שנה חמשה זה קרבן אלישמע בן־עמיהוד: פ	0.91698426
ביום השמיני נשיא לבני מנשה גמליאל בן־פדה־צור:	ביום השמיני נשיא לבני מנשה גמליאל בן־פדה־צור:	0.982376695
קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה :	קרבנו קערת־כסף אחת שלשים ומאה משקלה מזרק אחד כסף שבעים שקל בשקל הקדש שניהם ׀ מלאים סלת בלולה בשמן למנחה :	0.901778698
כף אחת עשרה זהב מלאה קטרת:	כף אחת עשרה זהב מלאה קטרת:	0.992877066
פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	פר אחד בן־בקר איל אחד כבש־אחד בן־שנתו לעלה:	0.99285382
שעיר־עזים אחד לחטאת:	שעיר־עזים אחד לחטאת:	0.995431066

Figure 50 – Output results between two bibles versions that the user / manager selects

Figure 51 – Results window

Figure 52 – Histogram window that represent in more comfortable way the results

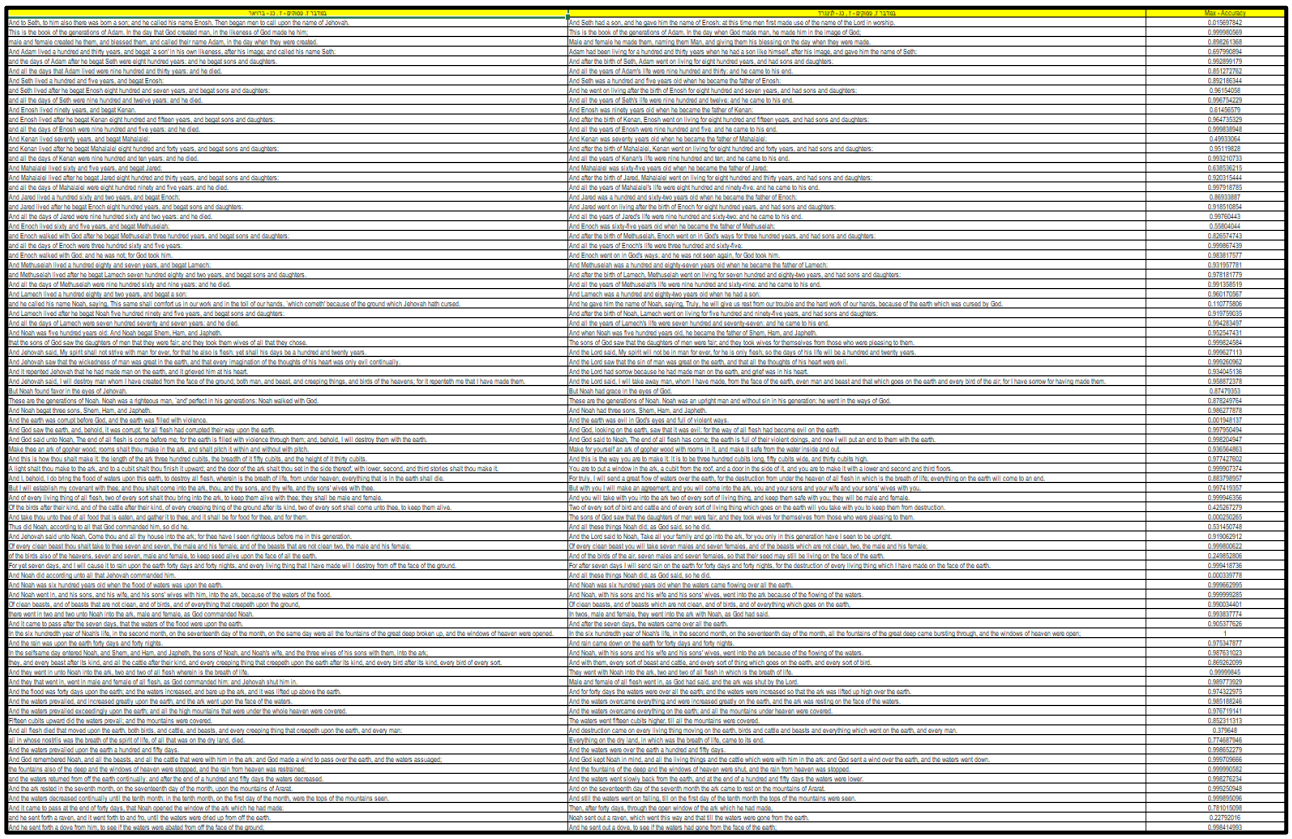
In this experiment we take two different bible versions and compare between them by the model of our system. The model does not use with data augmentation, its mean that he does not take some words from each version and replace them by their synonyms.

In this output result we see in more details the accuracy between sentences according to the prediction phase of the model. The prediction phase creates values of accuracy between 0 to 100. Also, the user / manager can see the results as histogram.

The parameters of the model in this example is: epochs number – 5, batch size – 50, training split – 0.6. Those parameters are not default parameters of the system. Note - only the manager can change the parameters of the model in the system.

For summary, in this example the accuracy between the versions is approximately 95% according to the model without data augmentation.

6.1.5. Fourth example – model with augmentation and without default parameters



And to Seth, to him also there was born a son; and he called his name Enosh. Then began men to call upon the name of Jehovah.	And Seth had a son, and he gave him the name of Enosh: at this time men first made use of the name of the Lord in worship.	0.016697842
This is the book of the generations of Adam. In the day that God created man, in the likeness of God made he him;	This is the book of the generations of Adam. In the day when God made man, he made him in the image of God;	0.999960569
male and female created he them, and blessed them, and called their name Adam, in the day when they were created.	Male and female he made them, naming them Man, and giving them his blessing on the day when they were made.	0.899261368
And Adam lived a hundred and thirty years, and begat [a son] in his own likeness, after his image, and called his name Seth:	Adam had been living for a hundred and thirty years when he had a son like himself, after his image, and gave him the name of Seth:	0.697990894
and the days of Adam after he begat Seth were eight hundred years, and he begat sons and daughters.	And after the birth of Seth, Adam went on living for eight hundred years, and had sons and daughters:	0.992899179
And all the days that Adam lived were nine hundred and thirty years; and he died.	And all the years of Adam's life were nine hundred and thirty; and he came to his end.	0.85127762
And Seth lived a hundred and five years, and begat Enosh:	And Seth was a hundred and five years old when he became the father of Enosh:	0.892186344
and Seth lived after he begat Enosh eight hundred and seven years, and begat sons and daughters:	And he went on living after the birth of Enosh for eight hundred and seven years, and had sons and daughters:	0.96154098
and all the days of Seth were nine hundred and twelve years, and he died.	And all the years of Seth's life were nine hundred and twelve; and he came to his end.	0.996574229
And Enosh lived ninety years, and begat Kenan:	And Enosh was ninety years old when he became the father of Kenan:	0.81456879
and Enosh lived after he begat Kenan eight hundred and fifteen years, and begat sons and daughters:	And after the birth of Kenan, Enosh went on living for eight hundred and fifteen years, and had sons and daughters:	0.964735329
and all the days of Enosh were nine hundred and five years; and he died.	And all the years of Enosh were nine hundred and five; and he came to his end.	0.995819548
And Kenan lived seventy years, and begat Mahalalel:	And Kenan was seventy years old when he became the father of Mahalalel:	0.49933064
and Kenan lived after he begat Mahalalel eight hundred and forty years, and begat sons and daughters:	And after the birth of Mahalalel, Kenan went on living for eight hundred and forty years, and had sons and daughters:	0.95119828
and all the days of Kenan were nine hundred and ten years; and he died.	And all the years of Kenan's life were nine hundred and ten; and he came to his end.	0.99321733
And Mahalalel lived sixty and five years, and begat Jared:	And Mahalalel was sixty-five years old when he became the father of Jared:	0.838536215
And Mahalalel lived after he begat Jared eight hundred and thirty years, and begat sons and daughters:	And after the birth of Jared, Mahalalel went on living for eight hundred and thirty years, and had sons and daughters:	0.920315444
and all the days of Mahalalel were eight hundred ninety and five years; and he died.	And all the years of Mahalalel's life were eight hundred and ninety-five; and he came to his end.	0.99579185
And Jared lived a hundred sixty and two years, and begat Enoch:	And Jared was a hundred and sixty-two years old when he became the father of Enoch:	0.88933887
and Jared lived after he begat Enoch eight hundred years, and begat sons and daughters:	And Jared went on living after the birth of Enoch for eight hundred years, and had sons and daughters:	0.918510854
And all the days of Jared were nine hundred sixty and two years; and he died.	And all the years of Jared's life were nine hundred and sixty-two; and he came to his end.	0.99760443
And Enoch lived sixty and five years, and begat Methuselah:	And Enoch was sixty-five years old when he became the father of Methuselah:	0.55804044
and Enoch walked with God after he begat Methuselah three hundred years, and begat sons and daughters:	And after the birth of Methuselah, Enoch went on in God's ways for three hundred years, and had sons and daughters:	0.826574743
and all the days of Enoch were three hundred sixty and five years:	And all the years of Enoch's life were three hundred and sixty-five:	0.999867439
and Enoch walked with God; and he was not, for God took him.	And Enoch went on in God's ways, and he was not seen again, for God took him.	0.983817577
And Methuselah lived a hundred eighty and seven years, and begat Lamech:	And Methuselah was a hundred and eighty-seven years old when he became the father of Lamech:	0.931607781
and Methuselah lived after he begat Lamech seven hundred eighty and two years, and begat sons and daughters:	And after the birth of Lamech, Methuselah went on living for seven hundred and eighty-two years, and had sons and daughters:	0.978181779
And all the days of Methuselah were nine hundred sixty and nine years, and he died.	And all the years of Methuselah's life were nine hundred and sixty-nine, and he came to his end.	0.99135819
And Lamech lived a hundred eighty and two years, and begat a son:	And Lamech was a hundred and eighty-two years old when he had a son:	0.965170367
and he called his name Noah, saying, This same shall comfort us in our work and in the toil of our hands, 'which cometh' because of the ground which Jehovah hath cursed.	And he gave him the name of Noah, saying, Truly, he will give us rest from our trouble and the hard work of our hands, because of the earth which was cursed by God.	0.110775806
And Lamech lived after he begat Noah five hundred ninety and five years, and begat sons and daughters.	And after the birth of Noah, Lamech went on living for five hundred and ninety-five years, and had sons and daughters:	0.919759035
And all the days of Lamech were seven hundred seventy and seven years, and he died.	And all the years of Lamech's life were seven hundred and seventy-seven; and he came to his end.	0.954283497
And Noah was five hundred years old: And Noah begat Shem, Ham, and Japheth.	And when Noah was five hundred years old, he became the father of Shem, Ham, and Japheth.	0.952547431
that the sons of God saw the daughters of men that they were fair; and they took them wives of all that they chose.	The sons of God saw that the daughters of men were fair; and they took wives for themselves from those who were pleasing to them.	0.999824584
And Jehovah said, My spirit shall not strive with man for ever, for that he also is flesh, yet shall his days be a hundred and twenty years.	And the Lord said, My spirit will not be in man for ever, for he is only flesh, so the days of his life will be a hundred and twenty years.	0.999627113
And Jehovah saw that the wickedness of man was great in the earth, and that every imagination of the thoughts of his heart was only evil continually.	And the Lord saw that the sin of man was great on the earth, and that all the thoughts of his heart were evil.	0.999260962
And it repented Jehovah that he had made man on the earth, and it grieved him at his heart.	And the Lord had sorrow because he had made man on the earth, and grief was in his heart.	0.83404536
And Jehovah said, I will destroy man whom I have created from the face of the ground; both man, and beast, and creeping things, and birds of the heavens; for it repenteth me that I have made them.	And the Lord said, I will take away man, whom I have made, from the face of the earth, even man and beast and that which goes on the earth and every bird of the air; for I have sorrow for having made them.	0.956872378
But Noah found favor in the eyes of Jehovah.	But Noah had grace in the eyes of God.	0.87479353
These are the generations of Noah. Noah was a righteous man, [and] perfect in his generations: Noah walked with God.	These are the generations of Noah. Noah was an upright man and without sin in his generation; he went in the ways of God.	0.875249764
And Noah begat three sons, Shem, Ham, and Japheth.	And Noah had three sons, Shem, Ham, and Japheth.	0.986277978
And the earth was corrupt before God, and the earth was filled with violence.	And the earth was evil in God's eyes and full of violent ways.	0.00194E137
And God saw the earth, and, behold, it was corrupt; for all flesh had corrupted their way upon the earth.	And God, looking on the earth, saw that it was evil; for the way of all flesh had become evil on the earth.	0.997950494
And God said unto Noah, The end of all flesh is come before me; for the earth is filled with violence through them; and, behold, I will destroy them with the earth.	And God said to Noah, The end of all flesh has come, the earth is full of their violent doings, and now I will put an end to them with the earth.	0.996204947
Make thee an ark of gopher wood; rooms shalt thou make in the ark, and shalt pitch it within and without with pitch.	Make for yourself an ark of gopher wood with rooms in it, and make it safe from the water inside and out.	0.936564863
And this is how thou shalt make it: the length of the ark three hundred cubits, the breadth of it fifty cubits, and the height of it thirty cubits.	And this is the way you are to make it: It is to be three hundred cubits long, fifty cubits wide, and thirty cubits high.	0.877427002
A light shalt thou make to the ark, and to a cubit shalt thou finish it upward; and the door of the ark shalt thou set in the side thereof; with lower, second, and third stories shalt thou make it.	You are to put a window in the ark, a cubit from the roof, and a door in the side of it, and you are to make it with a lower and second and third floors.	0.999907374
And I, behold, I do bring the flood of waters upon this earth, to destroy all flesh, wherein is the breath of life, from under heaven; everything that is in the earth shall die.	For truly, I will send a great flow of waters over the earth, for the destruction from under the heaven of all flesh in which is the breath of life; everything on the earth will come to an end.	0.883799057
But I will establish my covenant with thee; and thou shalt come into the ark, thou, and thy sons, and thy wife, and thy sons' wives with thee.	But with you I will make an agreement, and you will come into the ark, you and your sons and your wife and your sons' wives with you.	0.997419357
And of every living thing of all flesh, two of every sort shalt thou bring into the ark, to keep them alive with thee; they shall be male and female.	And you will take with you into the ark two of every sort of living thing, and keep them safe with you; they will be male and female.	0.999945356
Of the birds after their kind, and of the cattle after their kind, of every creeping thing of the ground after its kind, two of every sort shall come unto thee, to keep them alive.	Two of every sort of bird and cattle and of every sort of living thing which goes on the earth will you take with you to keep them from destruction.	0.425267279
And take thou unto thee of all food that is eaten, and gather it to thee; and it shall be for food for thee, and for them.	The sons of God saw that the daughters of men were fair; and they took wives for themselves from those who were pleasing to them.	0.000292265
Thus did Noah; according to all that God commanded him, so did he.	And all these things Noah did, as God said, so he did.	0.531450748
And Jehovah said unto Noah, Come thou and all thy house into the ark, for thee have I seen righteous before me in this generation.	And the Lord said to Noah, Take all your family and go into the ark, for you only in this generation have I seen to be upright.	0.919952912
Of every clean beast thou shalt take to thee seven and seven, the male and his female; and of the beasts that are not clean two, the male and his female;	Of every clean beast you will take seven males and seven females, and of the beasts which are not clean, two, the male and his female;	0.999800322
of the birds also of the heavens, seven and seven, male and female, to keep seed alive upon the face of all the earth.	And of the birds of the air, seven males and seven females, so that their seed may still be living on the face of the earth.	0.249852806
For yet seven days, and I will cause it to rain upon the earth forty days and forty nights; and every living thing that I have made will I destroy from off the face of the ground.	For after seven days I will send rain on the earth for forty days and forty nights, for the destruction of every living thing which I have made on the face of the earth.	0.999418736
And Noah did according unto all that Jehovah commanded him.	And all these things Noah did, as God said, so he did.	0.00939979
And Noah was six hundred years old when the flood of waters was upon the earth.	And Noah was six hundred years old when the waters came flowing over all the earth.	0.999662995
And Noah went in, and his sons, and his wife, and his sons' wives with him, into the ark, because of the waters of the flood.	And Noah, with his sons and his wife and his sons' wives, went into the ark because of the flowing of the waters.	0.999999285
Of clean beasts, and of beasts that are not clean, and of everything that creepeth upon the ground,	Of clean beasts, and of beasts which are not clean, and of birds, and of everything which goes on the earth,	0.999034401
there went in two and two unto Noah into the ark, male and female, as God commanded Noah.	In twos, male and female, they went into the ark with Noah, as God had said.	0.993837774
And it came to pass after the seven days, that the waters of the flood were upon the earth.	And after the seven days, the waters came over all the earth.	0.905377626
In the six hundredth year of Noah's life, in the second month, on the seventeenth day of the month, on the same day were all the fountains of the great deep broken up, and the windows of heaven were opened.	In the six hundredth year of Noah's life, in the second month, on the seventeenth day of the month, all the fountains of the great deep came bursting through, and the windows of heaven were open.	1
And the rain was upon the earth forty days and forty nights.	And rain came down on the earth for forty days and forty nights.	0.975347877
In the selfsame day entered Noah, and Shem, and Ham, and Japheth, the sons of Noah, and Noah's wife, and the three wives of his sons with them, into the ark;	And Noah, with his sons and his wife and his sons' wives, went into the ark because of the flowing of the waters.	0.98763 1023
they, and every beast after its kind, and all the cattle after their kind, and every creeping thing that creepeth upon the earth after its kind, and every bird after its kind, every bird of every sort.	And with them, every sort of beast and cattle, and every sort of thing which goes on the earth, and every sort of bird.	0.865262099
And they went in unto Noah into the ark, two and two of all flesh wherein is the breath of life.	They went with Noah into the ark, two and two of all flesh in which is the breath of life.	0.99999845
And they that went in, went in male and female of all flesh, as God commanded him: and Jehovah shut him in.	Male and female of all flesh went in, as God had said, and the ark was shut by the Lord.	0.989773929
And the flood was forty days upon the earth; and the waters increased, and bare up the ark, and it was lifted up above the earth.	And for forty days the waters were over all the earth, and the waters were increased so that the ark was lifted up high over the earth.	0.974322975
And the waters prevailed, and increased greatly upon the earth; and the ark went upon the face of the waters.	And the waters overcame everything and were increased greatly on the earth, and the ark was resting on the face of the waters.	0.985118246
And the waters prevailed exceedingly upon the earth; and all the high mountains that were under the whole heaven were covered.	And the waters overcame everything on the earth, and all the mountains under heaven were covered.	0.87EF19141
Fifteen cubits upward did the waters prevail; and the mountains were covered.	The waters went fifteen cubits higher, till all the mountains were covered.	0.852311313
And all flesh died that moved upon the earth, both birds, and cattle, and beasts, and every creeping thing that creepeth upon the earth, and every man:	And destruction came on every living thing moving on the earth, birds and cattle and beasts and everything which went on the earth, and every man.	0.3796448
all in whose nostrils was the breath of the spirit of life, of all that was on the dry land, died.	Everything on the dry land, in which was the breath of life, came to its end.	0.774687946
And the waters prevailed upon the earth a hundred and fifty days.	And the waters were over the earth a hundred and fifty days.	0.996652279
And God remembered Noah, and all the beasts, and all the cattle that were with him in the ark; and God made a wind to pass over the earth, and the waters assuaged;	And God kept Noah in mind, and all the living things and the cattle which were with him in the ark, and God sent a wind over the earth, and the waters went down.	0.995709666
the fountains also of the deep and the windows of heaven were stopped, and the rain from heaven was restrained;	And the fountains of the deep and the windows of heaven were shut, and the rain from heaven was stopped.	0.999900582
and the waters returned from off the earth continually; and after the end of a hundred and fifty days the waters decreased.	And the waters went slowly back from the earth, and at the end of a hundred and fifty days the waters were lower.	0.996276234
And the ark rested in the seventh month, on the seventeenth day of the month, upon the mountains of Ararat.	And on the seventeenth day of the seventh month the ark came to rest on the mountains of Ararat.	0.999250948
And the waters decreased continually until the tenth month; in the tenth month, on the first day of the month, were the tops of the mountains seen.	And still the waters went on falling, till on the first day of the tenth month the tops of the mountains were seen.	0.999895096
And it came to pass at the end of forty days, that Noah opened the window of the ark which he had made:	Then, after forty days, through the open window of the ark which he had made,	0.761015098
and he sent forth a raven, and it went forth to and fro, until the waters were dried up from off the earth.	Noah sent out a raven, which went this way and that till the waters were gone from the earth.	0.22750016
And he sent forth a dove from him, to see if the waters were abated from off the face of the ground;	And he sent out a dove, to see if the waters had gone from the face of the earth,	0.998414993

Figure 53 – Output results between two bibles versions that the user / manager selects

Figure 54 – Results window

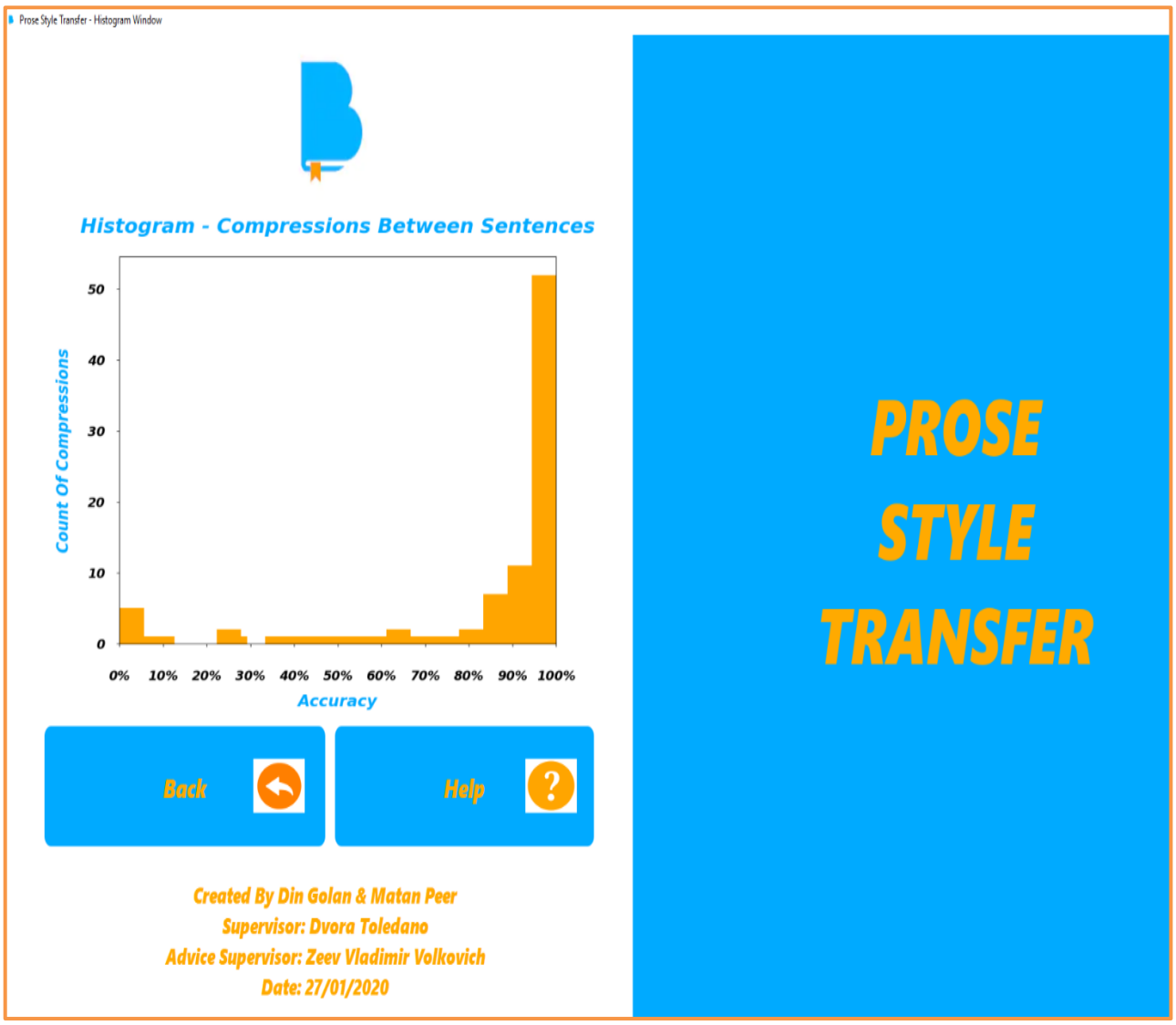


Figure 55 – Histogram window that represent in more comfortable way the results

In this experiment we take two different bible versions and compare between them by the model of our system. The model use with data augmentation, its mean that he takes some words from each version and replace them by their synonyms. This operation of changing word to her synonym effects on the accuracy of the compression, its mean that the accuracy can be lower than compression between versions without data augmentation, or it can be higher.

In this output result we see in more details the accuracy between sentences according to the prediction phase of the model. The prediction phase creates values of accuracy between 0 to 100. Also, the user / manager can see the results as histogram.

The parameters of the model in this example is: epochs number – 5, batch size – 50, training split – 0.6. Those parameters are not default parameters of the system. Note - only the manager can change the parameters of the model in the system.

For summary, in this example the accuracy between the versions is approximately 38% according to the model with data augmentation.

6.1.6. Compression between third and fourth examples

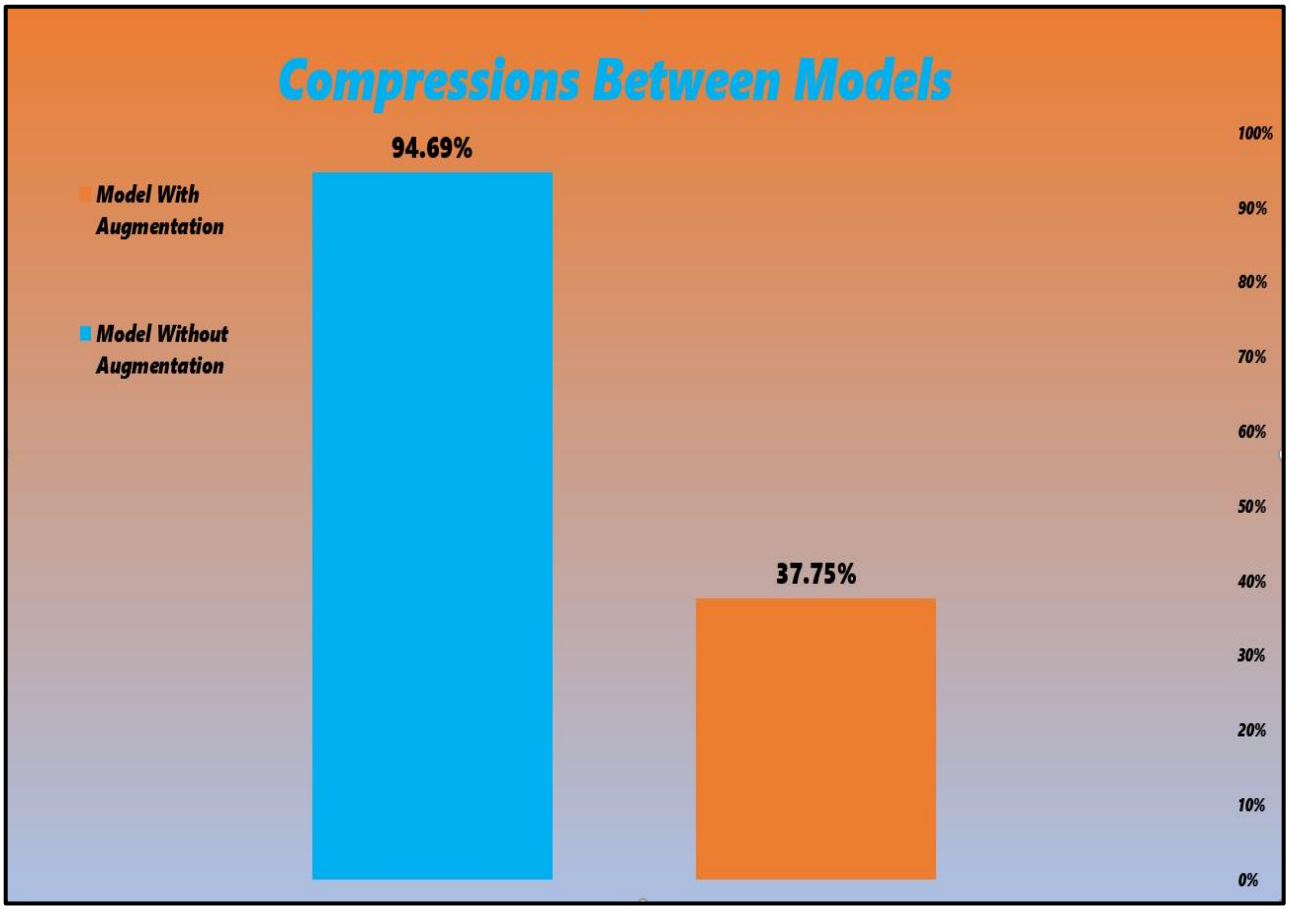


Figure 56 – Compression between model without data augmentation and model with data augmentation

6.2. Conclusions

At the experiment stage, we have created many models with different parameters, trying to understand better how the model responds to the various parameter's values. We learned at the section of learning process that small epoch number gives quite high accuracy and on the other hand, a relatively big epoch number causes over fitting. After deep thinking, we concluded that a different threshold value could contribute to various purposes of the application.

In the future, there is an option to expand the data set of Hebrew bibles, which can assist to improve the classification results. In addition, considering a possibility of a new Hebrew bible version, we suggest to repeating on the training process periodically.

We hope that our program will help to investigate the hypothesis that there have places in the bible that not written by human being.

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