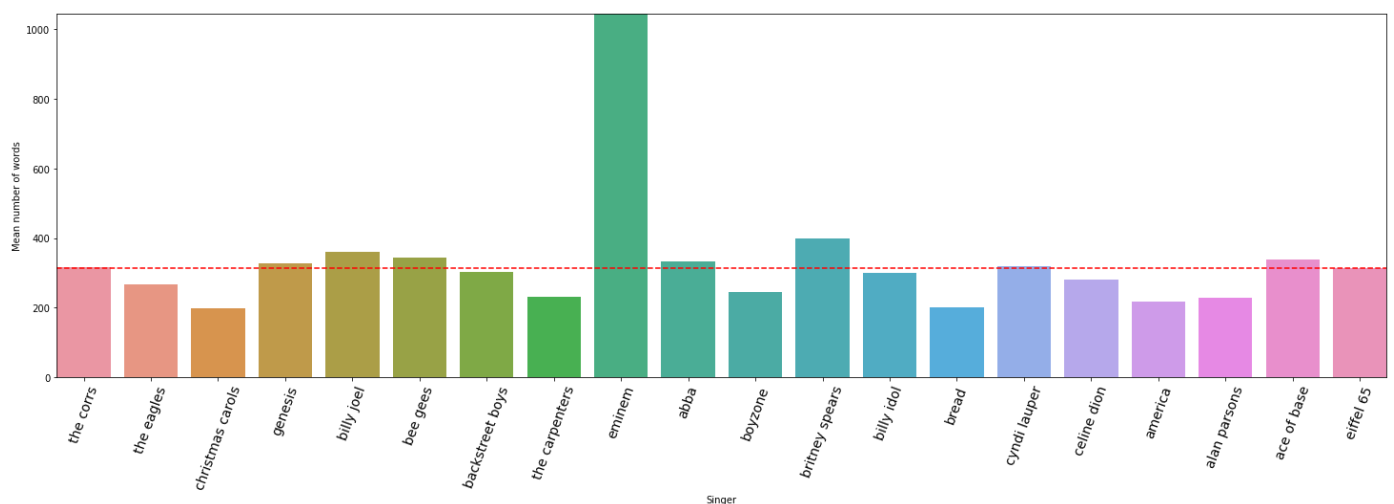
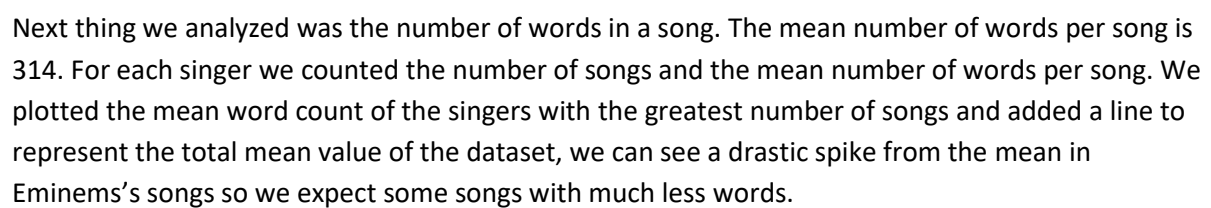


Amit Shakarchy- 313278889

ASSIGNMENT 2

In this section, we will describe an initial analysis of the data. The train set originally contained 599 songs, with their corresponding melody files. Some of the melody files were corrupted so we had to discard those leaving us with 589 songs. There are 225 different singers, most of them has only one or two songs, we plotted the singers with more than two song and the number of songs he had:



EXPERIMENTAL SETUP

Data:

- We divided the training set into train & validation sets, where the validation set's size is 20% of the original training subset.
- Preprocessing:
 - Lyrics:
 - Expanding contractions. For example- the term "it's" was expanded to "it is", "I'd" became "I would", etc.
 - For example:
On the left image- original song. On the right image- contractions expansion.

just relax take it easy
you're still young that's your fault
there's so much you have to know
find a girl settle down
if you want you can marry
look at me i am old but i'm happy

i was once like you are now
and i know that it's not easy
to be calm when you've found
something going on
but take your time think a lot
think of everything you've got
for you will still be here tomorrow
but your dreams may not

just relax take it easy
you are still young that is your fault
there is so much you have to know
find a girl settle down
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for you will still be here tomorrow
but your dreams may not

- Convert upper case letters to lower case.
- Removal of punctuation (except for the '&' sign that represents the end of a sentence)
- Word tokenization, split sentences into lists of words.
- Representation of the words using Word2Vec. For each term, we constructed a vector of 300 entries- as learned in class. We used the 'genism' library.

- Melody:
 - We removed from the dataset samples with corrupted MIDI files, since they cannot be loaded.
 - We normalized the melodies by the number of played instruments in a single note

- We normalized the melodies by the maximal note (of all melodies)

Network architecture:

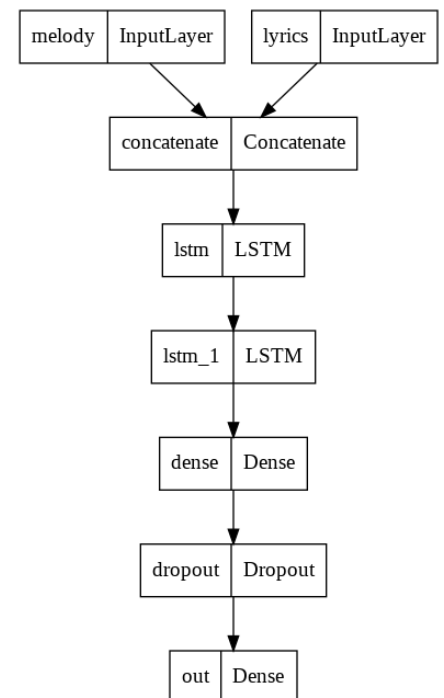
We implemented an LSTM network. During each training step, the network receives as an input one word of a song's lyrics (represented using Word2Vec), and a vector represents the melody (the two input approaches will be discussed later). On each phase, we concatenate the two inputs into one vector and feed it into 2 LSTM layers, followed by a fully connected layer and a dropout layer. A summary of the architecture (for one of the melody's integrations approaches):

Model: "model"

Layer (type)	Output Shape	Param #	Connected to
melody (InputLayer)	[(None, 1, 128)]	0	[]
lyrics (InputLayer)	[(None, 1, 300)]	0	[]
concatenate (Concatenate)	(None, 1, 428)	0	['melody[0][0]', 'lyrics[0][0]']
lstm (LSTM)	(None, 1, 64)	126208	['concatenate[0][0]']
lstm_1 (LSTM)	(None, 1, 64)	33024	['lstm[0][0]']
lstm_2 (LSTM)	(None, 64)	33024	['lstm_1[0][0]']
dense (Dense)	(None, 128)	8320	['lstm_2[0][0]']
dropout (Dropout)	(None, 128)	0	['dense[0][0]']
out (Dense)	(None, 7387)	952923	['dropout[0][0]']

=====

Total params: 1,153,499
Trainable params: 1,153,499
Non-trainable params: 0



Additional parameters:

- Batch size - 32.
- Epochs- 50, with an early stopping callback. After 20 epochs with no change at the loss rate- the training is stopped.
- Dropout rate- 0.2 – added in order to reduce the heavy overfitting of the models
- We used categorical cross-entropy loss. The output vector's size is the number of unique lyrics words in the training set.
- Optimizer- We used Adam optimizer with a decreasing learning rate.

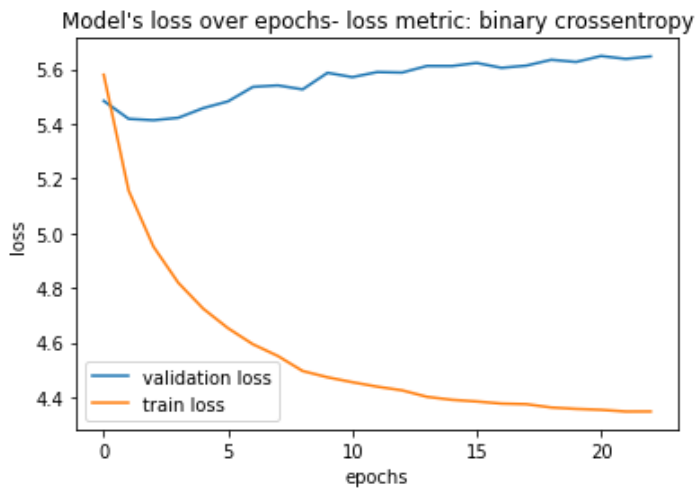
INTEGRATION OF MELODY INTO THE MODEL

First approach:

Use the entire melody as an input (like the approach that was suggested in the assignment instructions). In this approach, we use the piano roll of the MIDI file, normalized as described in the preprocessing section. Now the piano roll represents the average note value of the

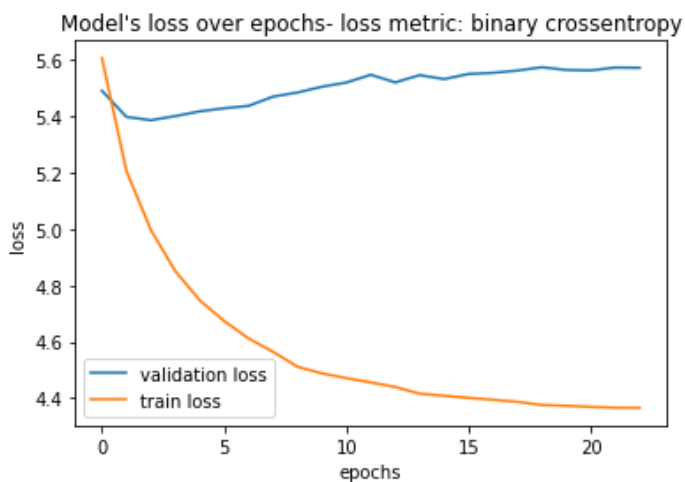
entire melody. The melody's vector, with size of (128,1), is concatenated with each word's embedding (with 300 entries).

The model's loss function:



Second approach:

Split the melody into segments. First, we had to include as much melody information as we could, so we summed all notes from all instruments. Then to scale the data, we normalized it first by the number of played instruments at the same time and note, second by the maximum value of a note, and third by the number of played notes at the same time. Eventually, we Split the Melody's notes into segments of {melody_units/num_of_words} units to represent a word.



In both approaches, it seems that the model converges, but overfits the training data. The reason for the poor results, we assume, is the instruction of feeding one word at a time to the model. This way, the model fails to learn the context of a single word and find it hard to predict the next word for unseen data.

1. Feed the model with several words to predict the next one, using a sliding window of 3 words for example.
2. Increase the dropout rate.
3. Adding another fully connected layer.
4. Using an attention mechanism.
5. Using regularization mechanisms.
6. Using data augmentation- using synonym replacement, for example.

USING THE MODEL AS A SONG GENERATOR

To generate each word, we applied to the model the former word, and sampled the next out of all the lyrics words. The likelihood of a word to be selected by the sampling is proportional to its probability. Here we show the 50 first words of each generated song:

Original first word:

Song's name	First approach (entire melody)	Second approach (segmented melody)
Eternal Flame (The Bangles)	close to i am you so mellow christmas bitch it quite you can be the air your lips my voice of time tonight there is looking baby baby yeah no more tears strong what i give me every i did not	close wrap cupid on and fine to pray that i am a brother woah with evil in your that he will start happy that is like you for it do not killing is nothing let it feels every west doing you could be
Honesty (Billi Joel)	if do in life through his apartment laugh better i am want out in mine five what you all with you just fallen and left to the desert it another gold teacher about who bad we are you believe they turn	if a feel i like more just find niggas listen to thank and buy please love is fine has window to know throw i know you cry through hunger can get us blue and now the city on the same to mean when i have
Lovefool (Cardigans)	dear your mind is your time victim and soon you mister we make me ooh i was you needed let me i am one and i am all he be home money that ole and that will not show i will save that	dear says anywhere kind of my mind shoe i stand along no guard before a ghost it will be as the laughter you and take it so missing of all a moment here i was some should there is you are sure

Barbie Girl (Aqua)	<i>hiya your way you feel you and the indecisions 's the sun on oh for and i were i want to really takes tonight you are all i can not really i love to show the roof on his fun that you just we</i>	<i>hiya each a damn once to stay to come you blind to you know can do de down around said the a new world but is it away copa just let your sweet left of a game dreams let me it i do</i>
All The Small Things (Blink 182)	<i>all it is free c'mon let me them i will hold again trying run the same you home let me up a woman on your ass smoke every dimension breaking die much your living baby and me it are startin</i>	<i>all around ahhh only off when you know seem it up bag and it as a drink yeah i thought to my heart sha bop closer his friend in this sister her could will feel i am a hero style to me rock you</i>

First word – “Love”:

Song's name	First approach (entire melody)	Second approach (segmented melody)
Eternal Flame (The Bangles)	<i>love i am like the dream see is dear it you are going to feel me somebody when you have you could be i think a letter to lean to say the keys days coz true you do not you this hot before you what is</i>	<i>love you i was you with you are not i was tha i would not get it is all you took like right and baby did you do not get to hide look by brother through the course are going for i got to the dance</i>
Honesty (Billi Joel)	<i>love was always be the game with the line when bad people stall in his room you reach because i got wrong i want to try like many closer oh oh yeah you in the times this color in my life and i will</i>	<i>love tonight with the pieces is just the name of life but my arms but please kick abacab take it was i am you are so to let me would time shoe in your she is love you say a new part</i>
Lovefool (Cardigans)	<i>love to not found for that i see i have to me i swear to dance in all looked is been what happens is the ground oh just his to turn but you might is not ever it does you smile but i believe i have to</i>	<i>love means i waited you you please and jitterbug night the painful on you i could be riot</i>

		<i>and i love to live as i feel the angels woman nigga feel me now and the past skies of dawn and lupe incredible</i>
Barbie Girl (Aqua)	<i>love the mornin would be feel it is no can not do not even we we will far of town with you i am the hear say that we call it is bad me it are only job my life i do the tropic</i>	<i>love that to spend you said and all so this way i moved in the move me that must then i want to spend on hurting anyone for you breathe back by 's one so you a price only time is too you do ron-ron- ron da do</i>
All The Small Things (Blink 182)	<i>love a open places now of are where mr. to be with baby do it oh you check tell me be came we heard not matter what love it was standin of low i said some you in me go you and</i>	<i>love and it is from simple and and just your stay why do not speak more a song for the children watch x4 you like a bottle queen on his soul to hide when we can understand the sun pum pum ha now</i>

First word – “Baby”:

Song's name	First approach (entire melody)	Second approach (segmented melody)
Eternal Flame (The Bangles)	<i>baby again it will not a apartment i am right she ever i want it late girl everything to dance under like they wonder a song right we both and i will be it snow and if i just your do not so not hurt here just no is</i>	<i>baby in the old a lot me just want to she always them that you did i got a and give me when i turned i will drag just sit no i could go if i do not even that one</i>
Honesty (Billi Joel)	<i>baby i do you got hard again from day ja me cut by until then love it for me tell divides alright in the years was thing my door way it that for comin does we saw in hell crept door me singing</i>	<i>baby a place it is so come on your shoes through you cry you got in the church my loneliness girl around let me help khan or me because i feel them from these there is crazy make baby about waits falling loving it do</i>
Lovefool (Cardigans)	<i>baby i have want to show she was i will be would another side to hear you could of the cake we do not you already it</i>	<i>baby baby him you babe while how to know them just beginning you are not talk girl a fool forever apart and when i saw</i>

	<i>and it for me uptown your body would buy and i do not be free oh yeah yeah</i>	<i>and you can always should in your mind and drinks on me they are riding of love around</i>
Barbie Girl (Aqua)	<i>baby this long still by night you to answer cold boys of my daisy you happy inside you were now that do not nothing you oh lost it all again it we feel the clouds with my heart we drank you give</i>	<i>baby should my here on the knife with you so unkind while that you hardly my heart slow in to get her lives you with my hopes everything you the speed bonny i will be love you i am i am right</i>
All The Small Things (Blink 182)	<i>baby i do nitro what not sit foot slim planetary that you only bad of me baby your shoulder stormy so to you do not talk that would be is going to know the workin drop there because i feel you know i make it is</i>	<i>baby and who the way i am the hand you are fed that makes of our mind mental in the oh oh oh you are cryin do not pass it is another freak the sand the the time that it is</i>

First word – “Happy”:

Song's name	First approach (entire melody)	Second approach (segmented melody)
Eternal Flame (The Bangles)	<i>happy they want to your clown to provide and believe in a genie more times same i ever afraid me duke two to pay is clear love me the line a trash he do not out of the world for me the thing</i>	<i>happy on the route all you can not hear because i can feel her said you know what they got as new wish and your place for the end are losing on the blinds at you do not give me the end of hollywood</i>
Honesty (Billi Joel)	<i>happy i am the music are always looks it when the kiss we heard me up it all my mind ten need me to try i need a victim quit to take to pray me to hold stand there never you see much</i>	<i>happy i would be the city all around me but i am you that i will never do not you are going to dance from all the dub to my car on my oh yeah yeah yeah when i will want to take forever it home</i>
Lovefool (Cardigans)	<i>happy this something fallen a love</i>	<i>happy are to he is on i pulled the finest along i rang</i>

	<i>i want to take you cried the levee up your hands days on the day life right with love that with i have i feel that scared i will talk it is got for the days she is die all</i>	<i>waterloo people the one late to hold mission again but if it is gone i will see and at the savior on now they have got times the devil and then the</i>
Barbie Girl (Aqua)	<i>happy our aubrey west singen and you will have alone believe not seem money and i am here if you are given no the side i am going to me i do ... good go ... just mine the days you happy of</i>	<i>happy let the neighborhood of us be the cold all my beautiful right about you are not easy as time from your loving until room sing you were the wonders i need you and turn together and get your sleep to go the poison place</i>
All The Small Things (Blink 182)	<i>happy at ooh whey woman with your love they are going to everyone upon another things because it is not belong your time else to be you got me got her loved myself i want you alone your lips it i read in the funkSinger</i>	<i>happy to go my good times there could lost i wish do kick me take on forever i am my war beat what we have tells and i let me i have to hurt what you well as i got to meet up</i>

It seems that the selection of the first word had its effect on the generated songs. We see that all songs generated were senseless, but when using the first word differently than the original first word, for the first few sentences, the context of the song involves the first word rather than the original context of the song. generally the generated lyrics seems real from first look but when reading it, it is nonsense.

SONG EXPLORATION

Let's look at "Barbie Girl", by Aqua:

*Hiya, Barbie
Hi, Ken
You want to go for a ride?
Sure, Ken
Jump in
I'm a Barbie girl, in the Barbie world
Life in plastic, it's fantastic
You can brush my hair, undress me everywhere
Imagination, life is your creation
Come on, Barbie, let's go party
I'm a Barbie girl, in the Barbie world
Life in plastic, it's fantastic
You can brush my hair, undress me everywhere
Imagination, life is your creation
I'm a blond bimbo girl in a fantasy world
Dress me up, make it tight, I'm your dolly*

You're my doll, rock'n'roll, feel the glamour in pink
 Kiss me here, touch me there, hanky panky
 You can touch
 You can play
 If you say, "I'm always yours"
 (ooh, oh)

Barbie girl is A pop song. It has a structure of 2-3 long lines, followed by short lines. If we take, for example, the generated songs (for the original word and a picked first word), we will see that in general- the approach of using the entire melody helped with keeping a similar line structure.

	Entire melody	Segmented melody
Original first word	<i>hiya your way you feel you and the indecisions 's the sun on oh for and i were i want to really takes tonight you are all i can not really i love to show the roof on his fun that you just we</i>	<i>hiya each a damn once to stay to come you blind to you know can do de down around said the a new world but is it away copa just let your sweet left of a game dreams let me it i do</i>
"Love" as first word	<i>love the mornin would be feel it is no can not do not even we we will far of town with you i am the hear say that we call it is bad me it are only job my life i do the tropic</i>	<i>love that to spend you said and all so this way i moved in the move me that must then i want to spend on hurting anyone for you breathe back by 's one so you a price only time is too you do ron-ron-ron da do</i>