

ARIES Project

Predicting life cycle of lithium ion cells

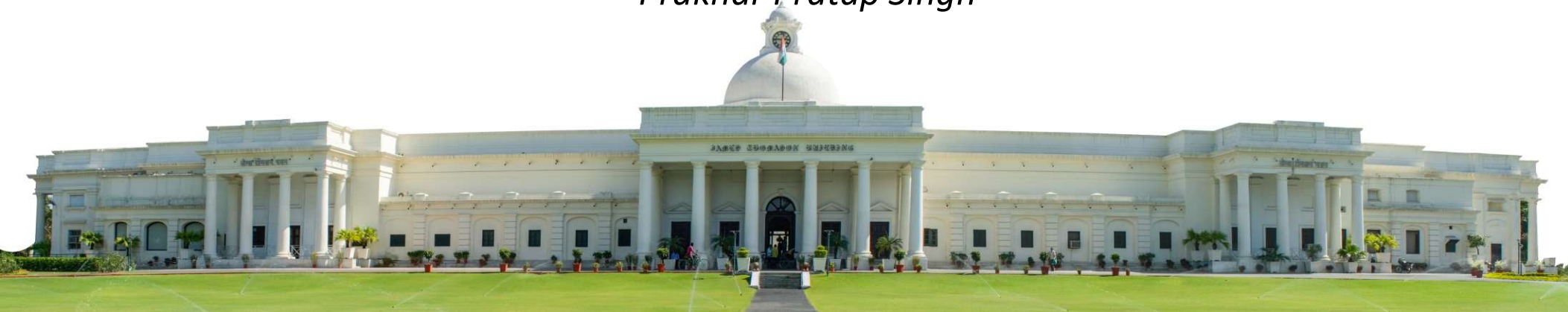
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DATASET

- For the selection of appropriate dataset having both new and used batteries we went through various available datasets such as unibo power tools NASA's randomized battery usage, NASA's battery datasheet but we finalized on [NASA's randomised battery data set](#).
- This dataset satisfies our need for used battery data and is sufficiently large to apply models that we planned to do.

Dataset continued...



Variables - data.step									
data									
data.step									
Fields	comment	type	time	relativeTime	voltage	current	temperature	date	
1	'reference charge'	'C'	1x1052 double	1x1052 double	1x1052 double	1x1052 double	1x1052 double	'06-Jan-20...	
2	'reference discharge'	'D'	1x757 double	1x757 double	1x757 double	1x757 double	1x757 double	'06-Jan-20...	
3	'reference charge'	'C'	1x1053 double	1x1053 double	1x1053 double	1x1053 double	1x1053 double	'06-Jan-20...	
4	'reference discharge'	'D'	1x756 double	1x756 double	1x756 double	1x756 double	1x756 double	'06-Jan-20...	
5	'pulsed load (rest)'	'R'	1x1201 double	1x1201 double	1x1201 double	1x1201 double	1x1201 double	'07-Jan-20...	
6	'pulsed load (discharge)'	'D'	1x601 double	1x601 double	1x601 double	1x601 double	1x601 double	'07-Jan-20...	
7	'pulsed load (rest)'	'R'	1x1201 double	1x1201 double	1x1201 double	1x1201 double	1x1201 double	'07-Jan-20...	
8	'pulsed load (discharge)'	'D'	1x601 double	1x601 double	1x601 double	1x601 double	1x601 double	'07-Jan-20...	
9	'pulsed load (rest)'	'R'	1x1201 double	1x1201 double	1x1201 double	1x1201 double	1x1201 double	'07-Jan-20...	
10	'pulsed load (discharge)'	'D'	1x601 double	1x601 double	1x601 double	1x601 double	1x601 double	'07-Jan-20...	
11	'pulsed load (rest)'	'R'	1x1201 double	1x1201 double	1x1201 double	1x1201 double	1x1201 double	'07-Jan-20...	
12	'pulsed load (discharge)'	'D'	1x601 double	1x601 double	1x601 double	1x601 double	1x601 double	'07-Jan-20...	
13	'pulsed load (rest)'	'R'	1x1201 double	1x1201 double	1x1201 double	1x1201 double	1x1201 double	'07-Jan-20...	
14	'pulsed load (discharge)'	'D'	1x601 double	1x601 double	1x601 double	1x601 double	1x601 double	'07-Jan-20...	
15	'pulsed load (rest)'	'R'	1x1201 double	1x1201 double	1x1201 double	1x1201 double	1x1201 double	'07-Jan-20...	
16	'pulsed load (discharge)'	'D'	1x601 double	1x601 double	1x601 double	1x601 double	1x601 double	'07-Jan-20...	
17	'pulsed load (rest)'	'R'	1x1201 double	1x1201 double	1x1201 double	1x1201 double	1x1201 double	'07-Jan-20...	
18	'pulsed load (discharge)'	'D'	1x601 double	1x601 double	1x601 double	1x601 double	1x601 double	'07-Jan-20...	

DATA Preprocessing

- The dataset was available in Matlab and R format but for our project we are using Matlab files.
- Each subset of the dataset contains 3-4 files and we have 7 such subsets.
- Due to lack of RAM and large training time only limited files could be used to train our model.
- The parameters available in this dataset include time, relative time, voltage, current and temperature.

Data Visualization

Voltage



Current



Data Visualization

Temperature

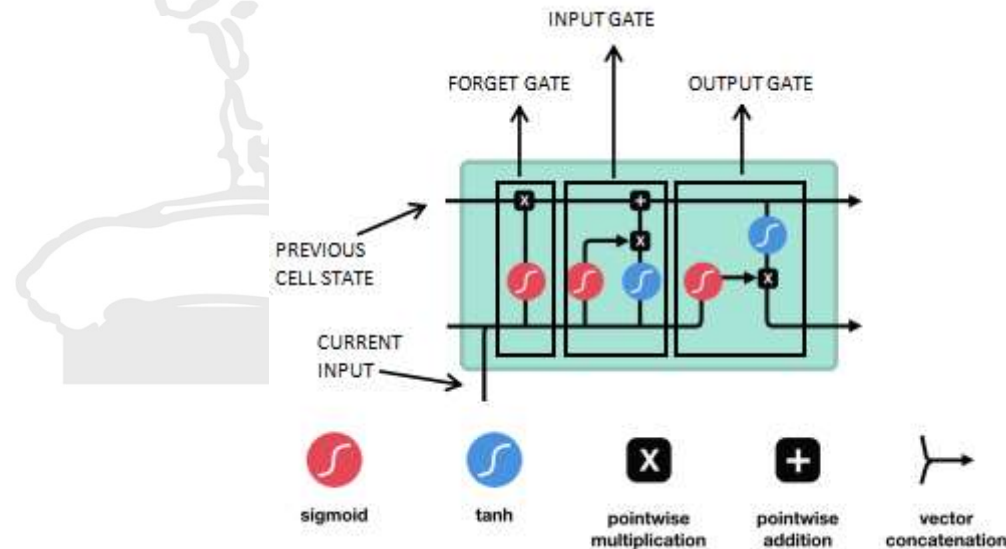


Model Selection

- The data used is in sequential form so we are applying LSTM(Long short term memory) model.
- Since it contains data in form of time series, therefore we can predict future state from past cycles of the battery.
- For application of LSTM we made certain changes in dataset and after pre-processing we created the variables like train_x, train_y, battery_n, time, etc. for easy application of the respected model

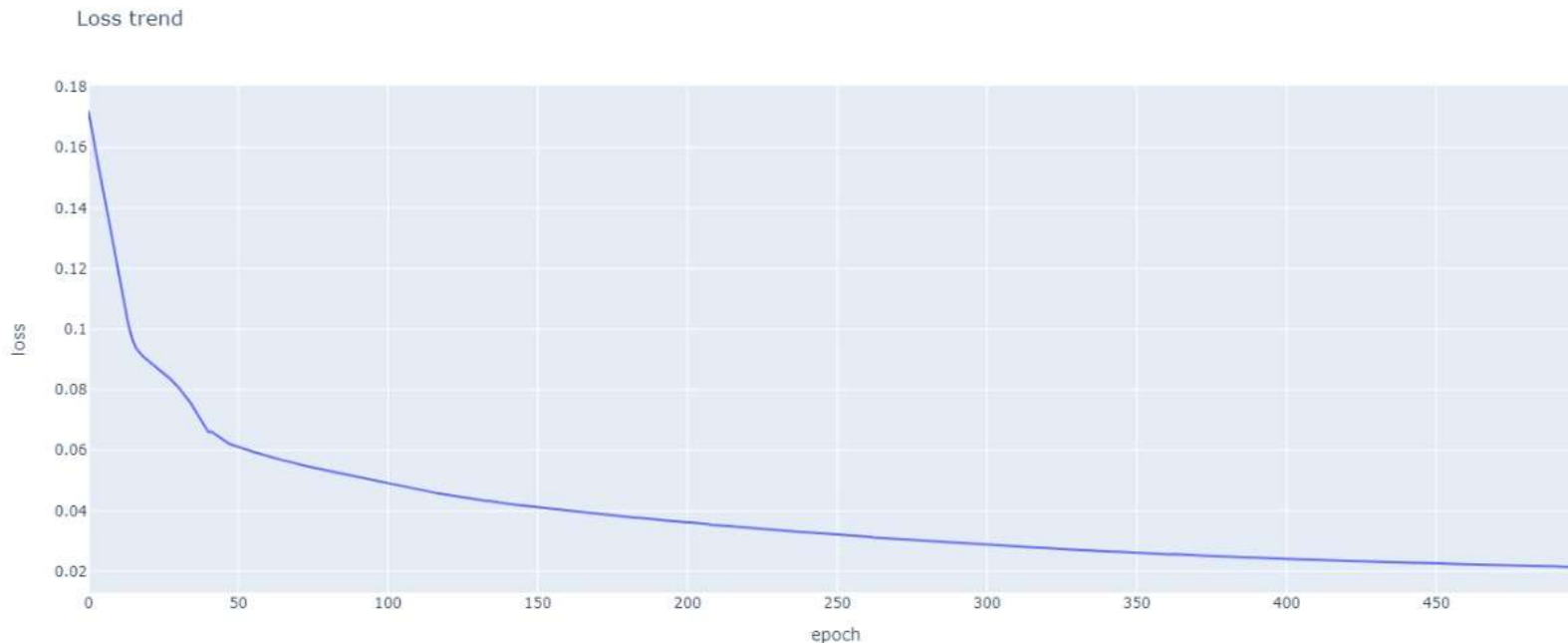
LSTM

- LSTM is complex Neural Network block used for modelling complex sequential data or time-series data.
- It is an improvement over RNN which has the problem of vanishing or exploding gradients causing the inability to remember longer contexts in the sequential data.



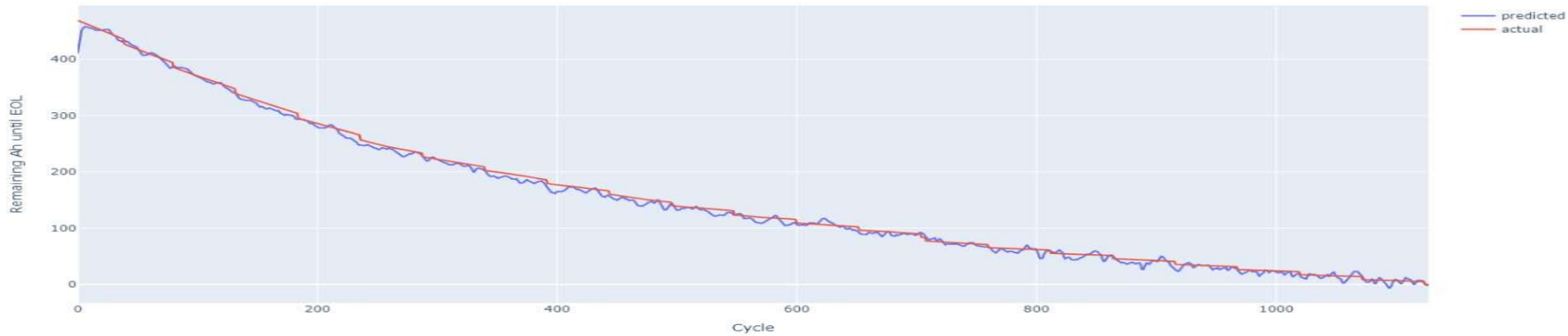
Training

- We have used Google collab for training our model.
- Training is done in batches of 32 with 500 epochs
- After the training our loss observed is 0.0214647688.

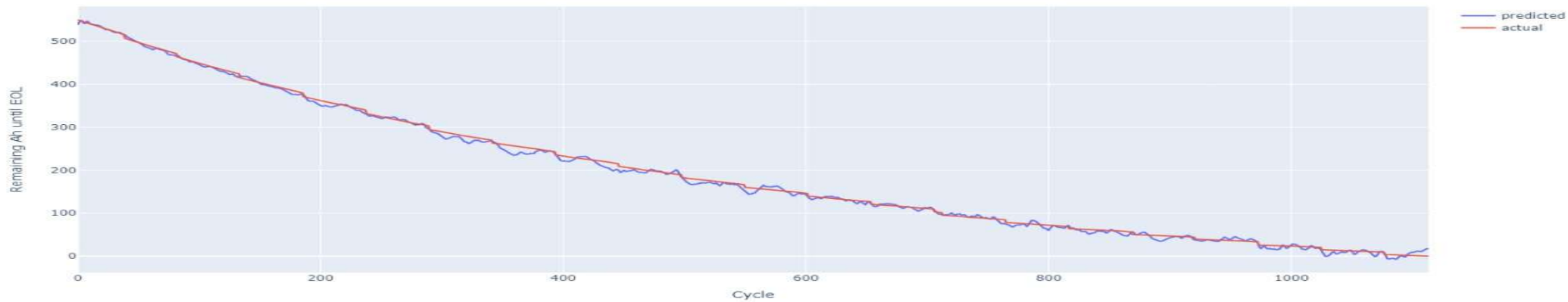


Results On Training

Results on training



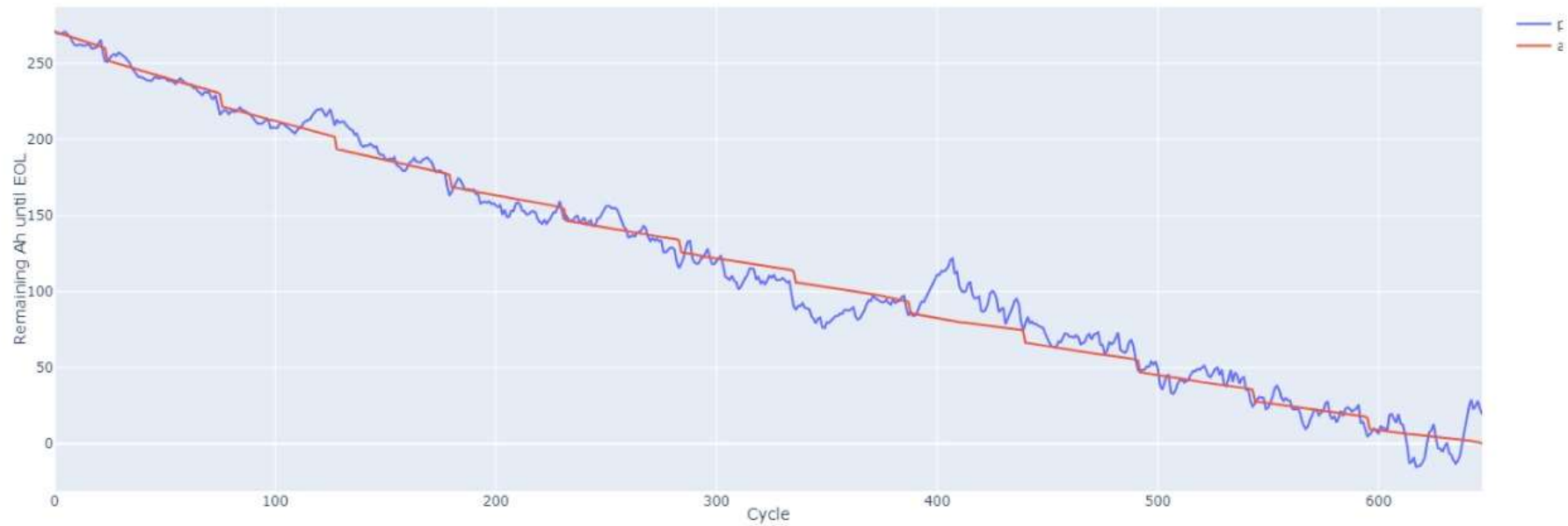
Results on training



Testing Losses

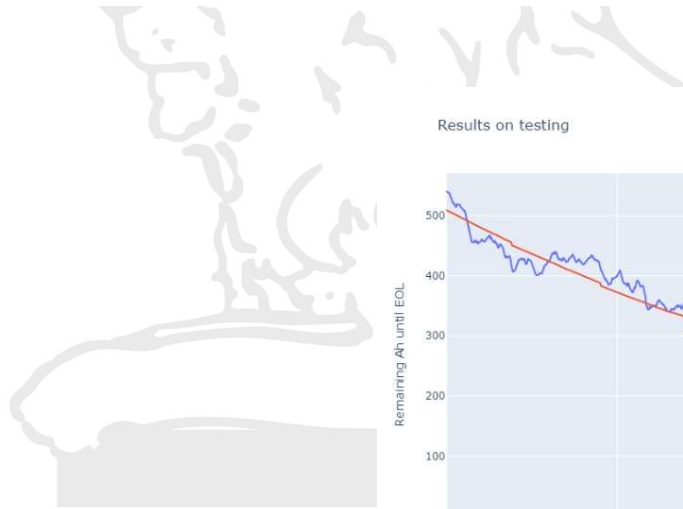
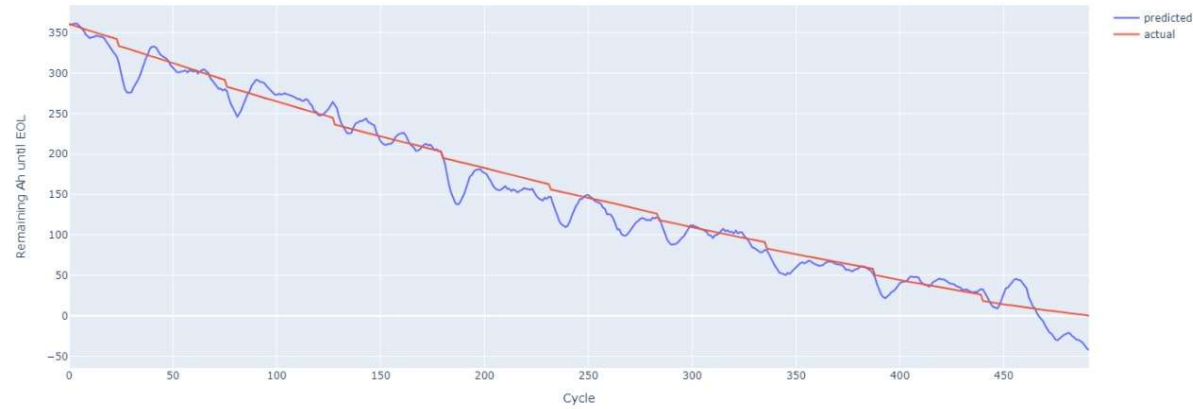
Data Set	MSE	MAE	RMSE
RW-11	0.001268685911782086	0.02864351123571396	0.0356186181306839
RW-15	0.007129967678338289	0.06200258806347847	0.08443913608789444
RW-24	0.0021113413386046886	0.03405878320336342	-0.04597912762174178
RW-28	0.001337920199148357	0.026978613808751106	0.03657759353518486

Results on testing

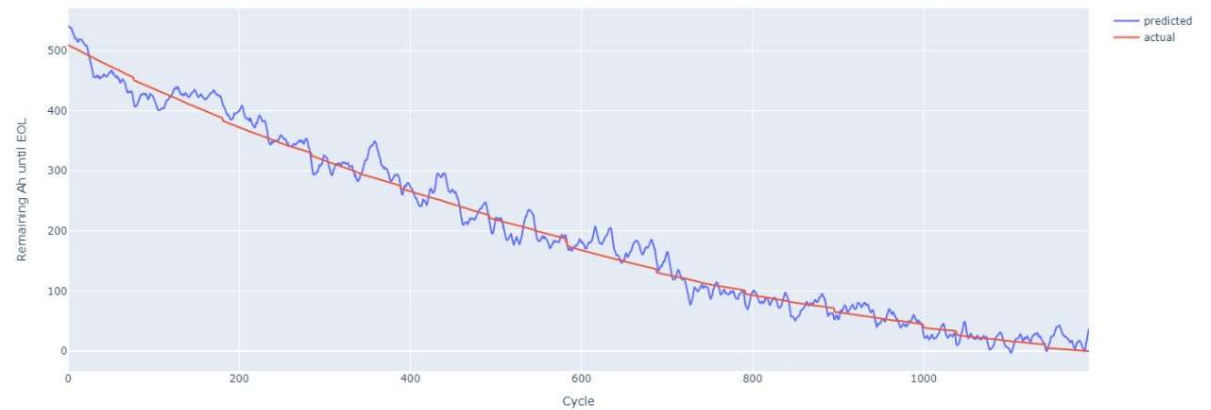


Results On Testing

Results on testing



Results on testing

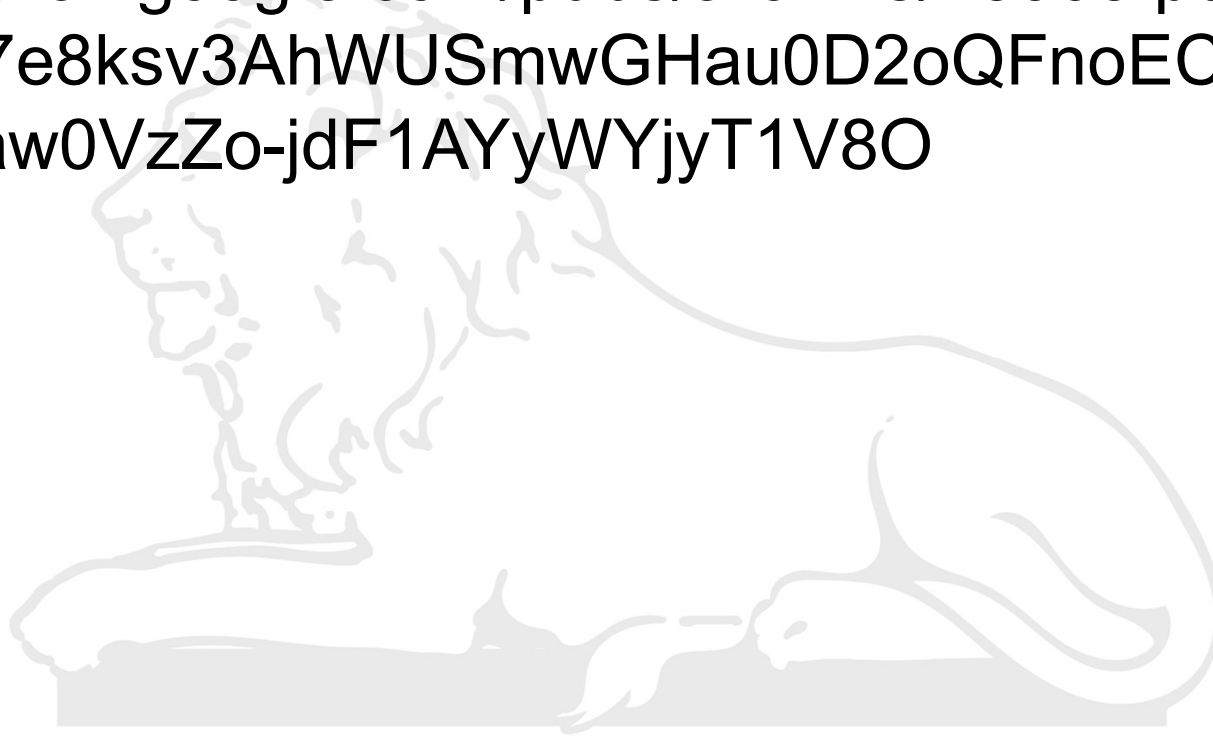


Future Goals

- We can reduce the losses by increasing the epochs (currently at 500) to 700 or 900.
- The current limitations on epochs is due to limitations in computational power of GPU.
- The efficiency might be increased by increasing the training data.
- The current limitation in training data at once is due to limitations in RAM available.

References

- https://github.com/pheonix8734/Aries_lithium_ion_project
- <https://www.google.com/url?sa=t&source=web&rct=j&url=https://research.google.com/pubs/archive/43905.pdf&ved=2ahUKEwiig7e8ksv3AhWUSmwGHau0D2oQFnoECAkQAQ&usg=AOvVaw0VzZo-jdF1AYyWYjyT1V8O>



Thank You