Title: Hyperparameter Tuning in LSTM Network

BACKGROUND
Dataset Used: IMDB Review dataset

HYPERPARAMETERS USED
1. Learning rate
2. Number of hidden units
3. Input Length
4. Number of Epochs

SEARCH METHODS USED
1. Random Search (RS)
2. Bayesian Optimization (BO)
3. Genetic Algorithm (GA)
4. Grid Search (GS)

RESEARCH QUESTIONS
- **RQ1**: How do the hyperparameter tuning techniques compare with each other?
- **RQ2**: Which set of above-mentioned hyperparameters yields the best results for LSTM?

RANDOM SEARCH
Arbitrary search in random search space.

BAYESIAN OPTIMIZATION
Guided search in random search space.

GENETIC ALGORITHM
- **Approach-I**
  - From 20 pass top one, create new 19, Relatively more difference in probability between high and poor performing models.
- **Approach-II**
  - From 20 pass best 10, create new 10. Relatively more difference in probability between high and poor performing models.
- **Approach-III**
  - From 20 pass best 10, create new 10. Relatively more difference in probability between high and poor performing models.

GRID SEARCH
5 top models [GA-I, GA-II. GA-III, RS, BO]

* Figure 1 taken from https://colah.github.io/posts/2015-08-Understanding-LSTMs/

Genetic Algorithm provides best result for finding and tuning **hyperparameters** for an **LSTM** network.

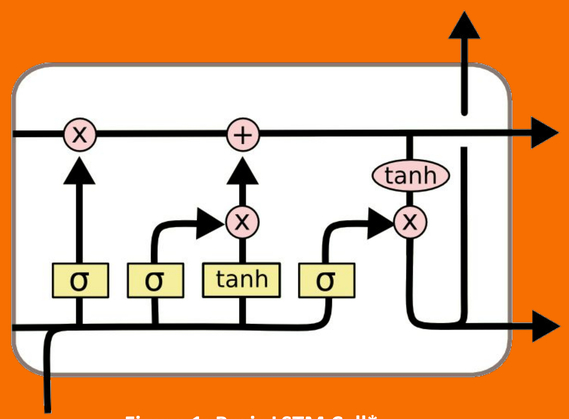

Figure 1: Basic LSTM Cell*

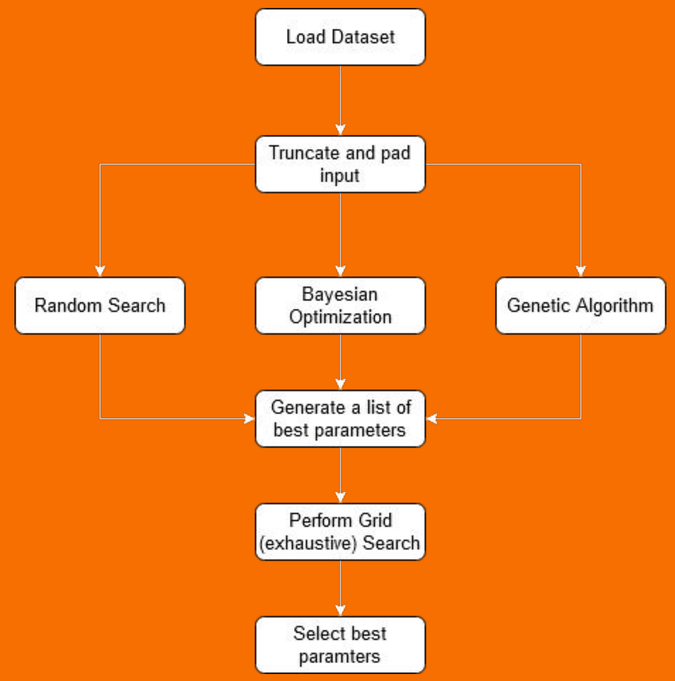

Figure 2: System Workflow

Method	Identified Optimum Hyperparameters				AUC	Time Taken
	α	numHidden	numEpochs	maxLength		
Random Search	0.018	464	5	458	0.896	1h14m
Bayesian Optimization	0.0031	278	7	422	0.9350	1h28m
GA Approach-I	0.012	54	3	429	0.9378	23h30m
GA Approach-II	0.017	112	4	418	0.934	8h46m
GA Approach-III	0.0075	85	3	475	0.946	14h22m
Final Grid Search	0.0075	85	3	475	0.946	7h5m

Take a picture to **download** the **full paper**

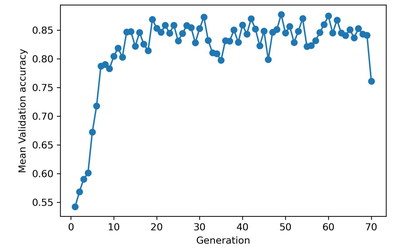

Fig: Validation accuracy for GA approach-III by generation

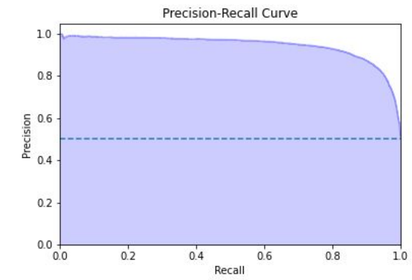

Fig: Area Under Precision-Recall Curve for GA approach-III

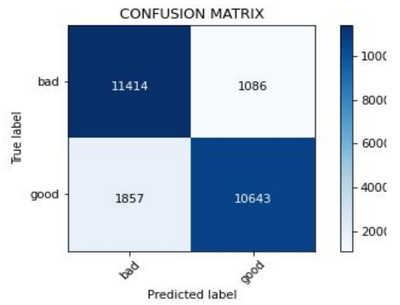

Fig: Confusion Matrix for GA approach-III

RESULTS
- Our approach for Genetic Algorithm yielded the best results.
- The best model has:
  AUC value: **0.946**.
  Precision: **0.90**, Recall: **0.85** and F1 score: **0.88**.

DISCUSSION
- Different approach to hyperparameter tuning were compared with respect to time and quality of results.
- Random search was the quickest whereas genetic algorithm gave the best result.

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