milestone3

June 16, 2021

1 Milestone 3

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CIS 700 Machine Learning and Security
06/16/2021

1.1 Theme:

"Adversarial Text Generation: Adversarial Machine Learning Applications in Text Analysis"

1.2 Purpose:

The purpose of this lab is to add three new GAN metrics to the project space and successfully run them on the chosen GAN models from previous milestones.

1.3 Project:

Texygen is the name of the project selected. This project is a benchmarking tool that aids in text generation model research and testing. This tool allows for ease of various model testing to compare accuracy and synthetic data generation of models using same training baseline.

1.4 (Hard/Soft)ware:

Google Colaboratory https://colab.research.google.com/
GPU Python 3 Google Compute Engine backend
Github https://github.com/eordanis/CIS-700/

1.5 Resources:

Original Source: https://github.com/geek-ai/Texygen
Modified Sources Acquired: 2SU Course Files Section -> Texygenmaster_Python_3.6.zip

1.6 Data:

The data for the selected project is setup as follows:
Generated data training: 5000 word and 20 sentence count
Oracle data generation: 10,000 sentence generation
Real data training:

- image_coco : 20,000 sentences chosen from the image
- COCO captions data. 10,000 of which are used as training set while other 10,000 used as test set
- emlp_news_min : 20,000 sentences
- A minified version of emlp_news : reduced from 278,586 lines of text in training data to 10,000 and also 10,000 for test. Trying to run real training on 1/4 of a million lines proved too taxing even on colab pro. minified version should yeild decent results comparable to image_coco, the project default.
- eapoe : 266 sentences
- eapoe : 266 sentences Compiled from various Edgar Allan Po Poems found on referenced poem sight [4].

1.7 Modifications:

To begin, the modified source code acquired from the 2SU application was further modified to combine the original intention of the origin source authors as well as professor modification. If no arguments are passed, all models/data are run. > **Note**: The order or model generation is done by first iterating over the GAN model type, then data type. If arguments are passed, those arguments will be validated and run accordingly to run a more targeted model test.

Modifications were applied to eliminate much library warnings and informational messages as to keep output as clean as possible. File path naming was updated to be compliant with Google Colaboratory environment. All epoch time elapse console printing has been commented out for cleaner output reading.

Modifications under previous course works: * Addition of three new GAN models * CGAN * InfoGAN * DCGAN

- Fixed LeakGAN project to work and run properly by setting standardized default flag attributes in main.py

- Update models to save off test files for each training type run (ie oracle, cfg, real)

- Updated models to use unified naming schema for test files, with model as the model the file was generated for and training as the training the data was generated from

  Example:

  - experiment-log-model-training.csv
  - oracle-model-training.txt
  - generator-model-training.txt
  - test_file-model-training.txt

- Updated models to set file name in main.py on the GAN model directly instead of in each model file themselves

- Added additional field called 'log_file' to be the name for the experiment-log file data
- Update to add new dir for midterm content vs milestone project
- Added new util called visual.py to handle data representation
- Allow visual.py to take directory param. if none exist, default to /content/CIS-700_clone/results
- Updated visual.py to grab files from directory and generate visual data representations from relevant files in a more automated and less hard coded way
- Allow main.py to take a results output directory via arg -o, if arg not present sets to results/
- Allow main.py to take value for epoch via -p arg to use in model training
- For argument provided training, added more detailed messaging as well as metric grid showing metrics that will be used during model generation
- Cleaned main.py and model files to limit print to console, additionally console print is uniform and consistent across.
- Added time elapsed pring statement for model run.

Modifications under this work: * Addition of three new metrics: * Time Elapse Interval (TEI) TEI measures time elapse for the model per epoch run. Used to measure average time efficiency to run model for each training during epochs. Helps gauge run time during various model training components (ie pre training and adversarial training) * Metric 2 * Metric 3

1.8 Setup:

Due to the heft of processor/gpu usage, it was deemed necessary to run the project in the Google Colaboratory. Original attempt to run was done via Pycharm IDE Professional Edition with Anaconda derived environments, however this proved too great of a strain on the accessible workstation.

Additionally, it is important to note if timeout is experienced, it is possible to run a ClickConnect script via inspector tools to prevent timeout while running long codes. The following code worked in chrome when inserted in the developer console at time of test:

```
let myClick = function ClickConnect({
console.log('Working - Preventing Timeout');
document.querySelector('colab-connect-button').shadowRoot.getElementById('connect').click();
}
setInterval(myClick,60000);
```

1.8.1 Step 1

A new Google Colaboratory workspace was setup, titled “Milestone2”. This workspace was run using the hosted runtime environment. This document is the current document being read.

In order to run against provided code base, it was necessary to sync the colab workspace the github repository files as follows

```
!git clone https://$GITHUB_AUTH@github.com/eordanis/CIS-700_clone/
```

Running this command from the first cell in the workbook syncs the drive to the github repo location of project location, as well as change to the necessary directory

[6]:
```
import shutil
# to prevent nesting problems, remove directory and its contents if exists
#if called to remove known existing, must restart runtime before cloning again
dir_path = '/content/CIS-700_clone'
try:
    shutil.rmtree(dir_path)
except OSError as e:
    print("Error: %s : %s" % (dir_path, e.strerror))
```

[ ]:
```
!git clone https://$GITHUB_AUTH@github.com/eordanis/CIS-700_clone/
%cd CIS-700_clone
```

1.8.2 Step 2

Now it was necessary to import and download any missing libraries the hosted colaborartoy runtime did not have readily available via the following commands:

```
!pip install -r "requirements.txt"
import nltk
nltk.download('punkt')
```

Running this command from the next cell in the workbook installed the necessary libraries and at specified versions for the project.

[ ]:
```
!pip install -r "requirements.txt"
import nltk
nltk.download('punkt')
```

1.8.3 Step 3

Now it is time to run the application. Below are two examples of commands to run the application.

```
!python3 "main.py"
```

This first command was run without parameters. In the case of this command, all trainings (SeqGAN, Gsgan, TextganMmd, Leakgan, Rankgan, Maligan, Mle) were run on all available defaulted training data (oracle LSTM, real data, CFG). Running this command can take around 2+ hours to complete.

```
!python3 "main.py" -g seqgan -t real
```

This second command was run with parameters. In the case of this command, main was run with SeqGAN training on image_coco. Running targeted trainings take less time to run, on average completing in 5-15 minutes depending on selected parameters. With the above selection, runtime was run above 10 minutes.

```
!python3 "main.py" -g seqgan -t real  -d data/eapoe.txt
```

This third command was run with parameters. In the case of this command, main was run with SeqGAN training on eapoe.

```
!python3 "main.py" -g seqgan -t real  -d data/eapoe.txt -o results/test/
```

This third command was run with parameters. In the case of this command, main was run with SeqGAN training on eapoe and results will output to results/test directory.

```
!python3 "main.py" -g seqgan -t real  -d data/eapoe.txt -o results/test/ -p 45
```

This fourth command was run with parameters. In the case of this command, main was run with SeqGAN training on eapoe and results will output to results/test directory and run on 45 epoch for both pre and adversarial training .

Running targeted trainings take less time to run, on average completing in 5-15 minutes depending on selected parameters. With the above selection, runtime was run above 10 minutes.

> **NOTE:** For above estimates, based around 5 epochs. Additionally, CFG training appears to have stopped working suddenly, unsure why broken. Therefore running without that option for the time being. Additionally, the LeakGan model failed entirely to run now due to flag errors, so this model was discarded from testing.

1.9 Overview

1.9.1 Process

When running the various models, there are similar steps for each. 1. Beginning Training – begin model training(s) 2. Set training - sets the desired model training method 3. Start model pre-train generator – uses the training data to pre-train the generator model 4. Start model pre-train discriminator - – uses the training data to pre-train the discriminator model 5. Model adversarial training – runs the model to generate results based on the test data and metrics applied 6. Finish Training – end of model training(s)

During training, each model training runs through several passes or epochs. For simplicity, base epoch is set to 5, with model training running thrice for 15 total epochs there abouts for each model trained on a particular data set.

1.9.2 Baseline Models

For this report, the TextGAN and SeqGAN models were run on oracle and real training types in the previous project milestone and will be used as the baseline for new model comparisons. The real training types essentially runs the data against the image_coco.txt caption data. The TextGAN and SeqGAN was developed by the source project team to improve on existing GAN networks.

With regards to TextGan, the goal of this model is to generate high quality realistic synthetic data while overcoming the convergence dilemma by using a generator that runs as a long short-term memory network and its discriminator a convolutional network. By matching high-dimension laten feature distributions of the testing and training data, this model over longer epochs has shown demonstrate a higher performance in quantitative evaluation, showing the TextGAN model can produce sentences that appear to have been written by a human, and not AI generated.

For the SeqGAN model, this also proved successful in generating realistic looking sentences via this generator process. A second model was selected for comparison purposes. SeqGAN's generator is based off the reinforcement learning stochastic policy, allowing SeqGAN to performing gradient policy update in order to circumvent differentiation issues in the generation. Its discriminator is run on complete sentences, and its results used as the reinforcement learning reward signal. According to source authors, this model boasted higher performance over others run.

1.9.3 New Models From Previous Milestone

1.9.4 CGAN - Conditional Generative Adversarial Network

Conditional adversarial network, or CGAN for short, is a basic modification of GAN that simply adds an additional layer that conditions both the descriminator and generator model layers. For this labs purposes, an existing GAN model was used as the base, and in both the Generator and Discriminator an embedded layer was incorporated as the first layer, used as the conditioning layer. For the sake of specificity, this GAN could actually be considered an CGSGAN, however for simplicity we will refer to is as simply CGAN.

1.9.5 INFOGAN

InfoGan is an adjusted simple version of GAN that seeks to maximize the mutual information of a fixed subset of GAN noise varaibles. It is able to achieve this by having numerous convolution layers added to a regular implemtation of a GAN that are connected at the end, this makes the additional cost of computation low. For the use of this lab an existing GAN was used as the base and the convolution layers were added and connected at the end.

1.9.6 DCGAN

Deep convolutional generative adversarial networks (DCGANs) are a class of convolutional networks (CNNs) aimed to incorporate unsupervised learning. Some key components of the DCGAN architecture are the use of the Tanh activation function for the generator's output layer, LeakyReLU activation in the discriminator, and the removal of any fully connected hidden layers. With these features, the original study conducted was able to create a robust DCGAN, achieving an 82.8% accuracy on the on the CIFAR-10 image dataset.

1.9.7 Metrics

Abbreviations: * BLEU - BiLingual Evaluation Understudy * GAN - Generative Adversarial Network * NLL - Negative Log-Likelihood * RL - Reinforcement Learning

Definitions * EmbSim – influenced by BLEU, used instead to compare the word embeddings vs BLEU's comparison of word similarity between two sentences or documents. * NLL-oracle :

applied to synthetic data to determine fitting via oracle language model standards. * NLL-test : dual to NLL-Oracle, used to determine a model's capability to fit to real test data

These measurement standards and more are discussed in the project directory's "/docs/evaluation.md" location.

1.9.8 New Metrics

Time Elapse Interval (TEI) TEI measures time elapse for the model per epoch run. Used to measure average time efficiency to run model for each training during epochs. Helps gauge run time during various model training components (ie pre training and adversarial training)

Metric 2 -

Metric 3 -

1.10 Test

For this project, we will use the following arguments

```
#directory to use for model results output
directory = '/content/CIS-700_clone/results/'

#data set location to use
data = '/content/CIS-700_clone/data/eapoe.txt'

#epoch values to run for pre and adversarial training
epoch = '5'
```

Epochs were increased left to run at 5 for the sake of time. However, it is noted that as according to original project sourcing, >= 45 epochs for the models display the best NLL loss results on epochs > 40, prior to that point results would be poorer. NLL loss values are indicated to be better the lower they are, so if these values trend downward, the models are improving. For EmbeddedSimilarity, higher values are desired for better results.

[ ]:
```
#data set location to use
data = '/content/CIS-700_clone/data/eapoe.txt'

# epoch values to run for pre and adversarial training
epoch = '5'
```

1.10.1 CGAN

The following commands are to run CGAN model on both oracle and real trainings.

NOTE: The real data essentially trained the model on the eapoe.txt data.

```
!python3 "main.py" -g cgan -t oracle -d $data -p $epoch
!python3 "main.py" -g cgan -t real -d $data -p $epoch
```

Oracle Training

```
[ ]: !python3 "main.py" -g cgan -t oracle -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 16:40:18.799004: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected

***************************************************************

Model Set:                    Cgan
Training Set:                 Oracle
Data Set:                     /content/CIS-700_clone/data/eapoe.txt
Epochs Set:                   2
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...

******** Beginning Training ********
Metrics Applied: nll-oracle, nll-test, EmbeddingSimilarity, tei
Pre-training Generator...
epoch:1         nll-oracle:10.191106    nll-test:7.988097
EmbeddingSimilarity:-0.1326516652602898 tei:3.8773093660672506
Pre-training Discriminator...
Adversarial Training...
epoch:3         nll-oracle:11.668121    nll-test:7.9321976
EmbeddingSimilarity:-0.1310718899443358 tei:3.5650301615397137
epoch:4         nll-oracle:12.524385    nll-test:7.962252
EmbeddingSimilarity:-0.13137854287565262        tei:4.706718750794729

******** Completed Training ********

Time Elapsed: 15mins:22secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

Real Training

```
[ ]: !python3 "main.py" -g cgan -t real -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 16:55:45.167745: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected
```

```
***************************************************************

Model Set:                    Cgan
Training Set:                 Real
Data Set:                     /content/CIS-700_clone/data/eapoe.txt
Epochs Set:                   2
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...

******** Beginning Training ********
Metrics Applied: nll-test, EmbeddingSimilarity, tei
Pre-training Generator...
epoch:1         EmbeddingSimilarity:-0.3354938782021049 nll-test:5.92697
tei:0.692581840356191
Pre-training Discriminator...
Adversarial Training...
epoch:3         EmbeddingSimilarity:-0.28687007822271887        nll-
test:5.8982105      tei:0.7077780803044637
epoch:4         EmbeddingSimilarity:-0.23885877072914108        nll-
test:5.9341717      tei:1.237090524037679

******** Completed Training ********

Time Elapsed: 03mins:18secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

1.10.2 DCGAN

The following commands are to run DCGAN model on both oracle and real trainings.

> **NOTE:** The real data essentially trained the model on the eapoe.txt data.

```
!python3 "main.py" -g dcgan -t oracle -d $data -p $epoch
!python3 "main.py" -g dcgan -t real -d $data -p $epoch
```

Oracle Training

[ ]:
```
!python3 "main.py" -g dcgan -t oracle -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 17:17:30.646931: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected
```

```
***************************************************************

Model Set:                    Dcgan
Training Set:                 Oracle
Data Set:                     /content/CIS-700_clone/data/eapoe.txt
Epochs Set:                   2
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...

******** Beginning Training ********
Metrics Applied: nll-oracle, nll-test, EmbeddingSimilarity, tei
Pre-training Generator...
epoch:1         nll-oracle:10.775991    nll-test:7.598728
EmbeddingSimilarity:-0.21293872128091426        tei:2.8558653076489766
Pre-training  Discriminator...
Adversarial Training...
epoch:3         nll-oracle:10.58624     nll-test:7.473827
EmbeddingSimilarity:-0.20751336738059672        tei:2.7763562401135764
epoch:4         nll-oracle:10.53315     nll-test:7.481555
EmbeddingSimilarity:-0.20706436132658604        tei:5.848397306601206

******** Completed Training ********

Time Elapsed: 15mins:43secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

Real Training

```
[ ]: !python3 "main.py" -g dcgan -t real -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 17:33:17.589711: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected

***************************************************************

Model Set:                    Dcgan
Training Set:                 Real
Data Set:                     /content/CIS-700_clone/data/eapoe.txt
Epochs Set:                   2
```

```
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...

******** Beginning Training ********
Metrics Applied: nll-test, EmbeddingSimilarity, tei
Pre-training Generator...
epoch:1         EmbeddingSimilarity:-1.2232292105030942 nll-test:6.197953
tei:0.6899575153986613
Pre-training  Discriminator...
Adversarial Training...
epoch:3         EmbeddingSimilarity:-1.1395991220623776 nll-test:6.0936832
tei:0.9527965068817139
epoch:4         EmbeddingSimilarity:-1.1583808934733226 nll-test:6.102003
tei:1.8513996362686158

******** Completed Training ********

Time Elapsed: 04mins:34secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

1.10.3 INFOGAN

The following commands are to run INFOGAN model on both oracle and real trainings.

NOTE: The real data essentially trained the model on the eapoe.txt data.

```
!python3 "main.py" -g infogan -t oracle -d $data -p $epoch
!python3 "main.py" -g infogan -t real -d $data -p $epoch
```

Oracle Training

[ ]:
```
!python3 "main.py" -g infogan -t oracle -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 16:59:06.792622: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected

***************************************************************

Model Set:                    Infogan
Training Set:                 Oracle
Data Set:                     /content/CIS-700_clone/data/eapoe.txt
```

```
Epochs Set:                   2
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...

******** Beginning Training ********
Metrics Applied: nll-oracle, nll-test, EmbeddingSimilarity, tei
Pre-training  Generator...
epoch:1         nll-oracle:10.775991    nll-test:7.598728
EmbeddingSimilarity:-0.2126788559914403 tei:2.8538146018981934
Pre-training   Discriminator...
Adversarial Training...
epoch:3         nll-oracle:10.577665    nll-test:7.4738894
EmbeddingSimilarity:-0.20958604916026657        tei:2.650757205486298
epoch:4         nll-oracle:10.5361      nll-test:7.4805984
EmbeddingSimilarity:-0.2047540837455446 tei:5.1692455569903055

******** Completed Training ********

Time Elapsed: 14mins:20secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

Real Training

```
[ ]: !python3 "main.py" -g infogan -t real -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 17:13:31.165380: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected

***************************************************************

Model Set:                    Infogan
Training Set:                 Real
Data Set:                     /content/CIS-700_clone/data/eapoe.txt
Epochs Set:                   2
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...
```

```
******** Beginning Training ********
Metrics Applied: nll-test, EmbeddingSimilarity, tei
Pre-training  Generator...
epoch:1         EmbeddingSimilarity:-1.1226724352617905 nll-test:6.1940403
tei:0.7054317911465963
Pre-training   Discriminator...
Adversarial Training...
epoch:3         EmbeddingSimilarity:-1.1758314921480626 nll-test:5.9220543
tei:0.8328717629114787
epoch:4         EmbeddingSimilarity:-1.069669956265344  nll-test:5.9300427
tei:1.5426879088083902

******** Completed Training ********

Time Elapsed: 03mins:55secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

1.10.4 SeqGAN

The following commands are to run SeqGAN model on both oracle and real trainings.
NOTE: The real data essentially trained the model on the eapoe.txt data.

```
!python3 "main.py" -g seqgan -t oracle -d $data -p $epoch
!python3 "main.py" -g seqgan -t real -d $data -p $epoch
```

Oracle Training

[ ]:
```
!python3 "main.py" -g seqgan -t oracle -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 16:12:58.853681: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected

***************************************************************

Model Set:                     Seqgan
Training Set:                  Oracle
Data Set:                      /content/CIS-700_clone/data/eapoe.txt
Epochs Set:                    2
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...
```

```
******** Beginning Training ********
Metrics Applied: nll-oracle, nll-test, EmbeddingSimilarity, tei
Pre-training Generator...
epoch:1         nll-oracle:10.775991    nll-test:7.598728
EmbeddingSimilarity:-0.21296088291678061        tei:2.874186301231384
Pre-training  Discriminator...
Adversarial Training...
epoch:3         nll-oracle:10.579702    nll-test:7.4737377
EmbeddingSimilarity:-0.2071975437129076 tei:2.633168359597524
epoch:4         nll-oracle:10.531539    nll-test:7.4805455
EmbeddingSimilarity:-0.20629056130732434        tei:5.189106790224711

******** Completed Training ********

Time Elapsed: 14mins:20secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

Real Training

```
[ ]: !python3 "main.py" -g seqgan -t real -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 16:27:22.951686: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected

***************************************************************

Model Set:                    Seqgan
Training Set:                 Real
Data Set:                     /content/CIS-700_clone/data/eapoe.txt
Epochs Set:                   2
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...

******** Beginning Training ********
Metrics Applied: nll-test, EmbeddingSimilarity, tei
Pre-training Generator...
epoch:1         EmbeddingSimilarity:-1.1413055173973534 nll-test:6.119854
tei:0.700960099697113
Pre-training  Discriminator...
Adversarial Training...
```

```
epoch:3         EmbeddingSimilarity:-1.1780925624187852 nll-test:5.674348
tei:0.8338672200838725
epoch:4         EmbeddingSimilarity:-1.1161910970184497 nll-test:5.6040373
tei:1.5342828591664632

******** Completed Training ********

Time Elapsed: 03mins:55secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

1.10.5 TextGAN

The following commands are to run TextGAN model on both oracle and real trainings.
NOTE: The real data essentially trained the model on the eapoe.txt data.

```
!python3 "main.py" -g textgan -t oracle -d $data -p $epoch
!python3 "main.py" -g textgan -t real -d $data -p $epoch
```

Oracle Training

[ ]:
```
!python3 "main.py" -g textgan -t oracle -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 18:06:23.260313: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected

***************************************************************

Model Set:                    Textgan
Training Set:                 Oracle
Data Set:                     /content/CIS-700_clone/data/eapoe.txt
Epochs Set:                   2
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...

******** Beginning Training ********
Metrics Applied: nll-oracle, nll-test, EmbeddingSimilarity, tei
Pre-training  Generator...
epoch:1         nll-oracle:12.147542    nll-test:40.156467
EmbeddingSimilarity:-0.19626693796259828        tei:2.5959528923034667
Pre-training  Discriminator...
Adversarial Training...
```

```
epoch:3         nll-oracle:12.170656    nll-test:39.163532
EmbeddingSimilarity:-0.23198435490973648        tei:2.1661738753318787
epoch:4         nll-oracle:12.179794    nll-test:39.190224
EmbeddingSimilarity:-0.23490710926510586        tei:1.7391259829203287

******** Completed Training ********

Time Elapsed: 06mins:38secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

Real Training

```
[ ]: !python3 "main.py" -g textgan -t real -d $data -p $epoch
```

```
Unspecified Output Director Location: Defaulting to --> results/
2021-05-20 18:13:06.001560: E
tensorflow/stream_executor/cuda/cuda_driver.cc:328] failed call to cuInit:
CUDA_ERROR_NO_DEVICE: no CUDA-capable device is detected

***************************************************************

Model Set:                    Textgan
Training Set:                 Real
Data Set:                     /content/CIS-700_clone/data/eapoe.txt
Epochs Set:                   2
Results Output Directory Set: results/

***************************************************************

Recording Time Elapse...

******** Beginning Training ********
Metrics Applied: nll-test, EmbeddingSimilarity, tei
Pre-training  Generator...
epoch:1         EmbeddingSimilarity:-0.353344198819331  nll-test:38.232872
tei:0.6738850911458333
Pre-training  Discriminator...
Adversarial Training...
epoch:3         EmbeddingSimilarity:-0.4119618049065459 nll-test:37.452164
tei:0.7343119502067565
epoch:4         EmbeddingSimilarity:-0.4480797968253978 nll-test:37.716827
tei:0.8077659924825032

******** Completed Training ********
```

```
Time Elapsed: 02mins:19secs
```

For below model training and test, results are discussed later.
For more details, see Section **??**.

1.11 Results Comparision

Below sections are broken down into Data and Visual Representations of the results testing of models.

1.11.1 Data Representation

Below is a display of the best values for each training of each model run.

[3]:
```
import utils.visual as vis
vis.display_best_values()
```

```
********************************
        Oracle Training:
********************************
Cgan
        nll-oracle: 10.1911 @epoch 1    nll-test: 7.9322 @epoch 3
EmbeddingSimilarity: -0.1311 @epoch 3   tei: 3.565 @epoch 3

Dcgan
        nll-oracle: 10.5331 @epoch 4    nll-test: 7.4738 @epoch 3
EmbeddingSimilarity: -0.2071 @epoch 4   tei: 2.7764 @epoch 3

Infogan
        nll-oracle: 10.5361 @epoch 4    nll-test: 7.4739 @epoch 3
EmbeddingSimilarity: -0.2048 @epoch 4   tei: 2.6508 @epoch 3

Seqgan
        nll-oracle: 10.5315 @epoch 4    nll-test: 7.4737 @epoch 3
EmbeddingSimilarity: -0.2063 @epoch 4   tei: 2.6332 @epoch 3

Textgan
        nll-oracle: 12.1475 @epoch 1    nll-test: 39.1635 @epoch 3
EmbeddingSimilarity: -0.1963 @epoch 1   tei: 1.7391 @epoch 4

********************************
        Real Training:
********************************
Cgan
        EmbeddingSimilarity: -0.2389 @epoch 4   nll-test: 5.8982 @epoch 3
tei: 0.6926 @epoch 1

Dcgan
```

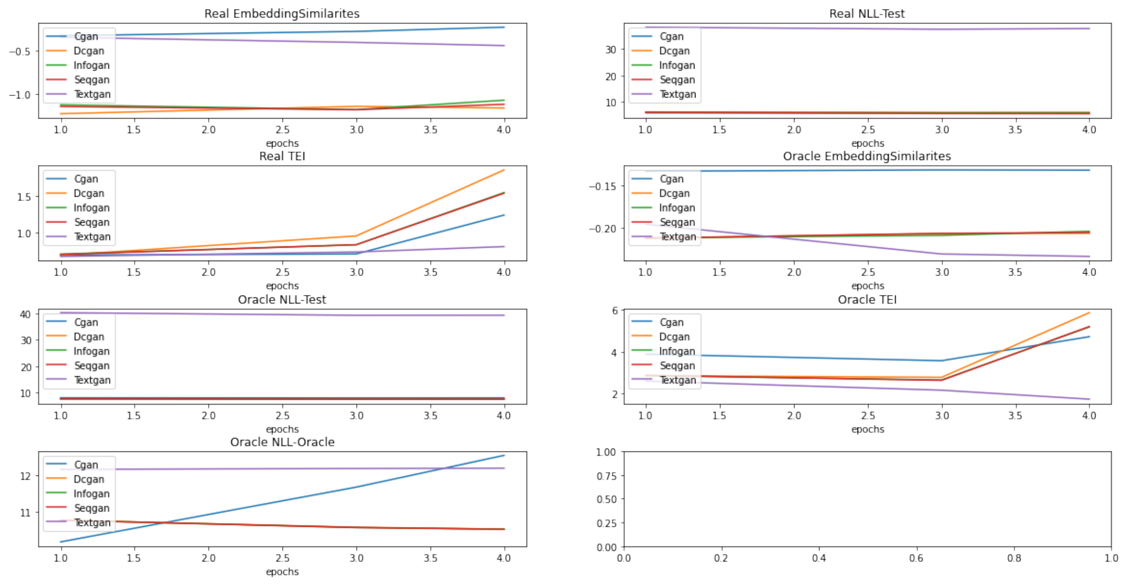
```
        EmbeddingSimilarity: -1.1396 @epoch 3   nll-test: 6.0937 @epoch 3
tei: 0.69 @epoch 1

Infogan
        EmbeddingSimilarity: -1.0697 @epoch 4   nll-test: 5.9221 @epoch 3
tei: 0.7054 @epoch 1

Seqgan
        EmbeddingSimilarity: -1.1162 @epoch 4   nll-test: 5.604 @epoch 4
tei: 0.701 @epoch 1

Textgan
        EmbeddingSimilarity: -0.3533 @epoch 1   nll-test: 37.4522 @epoch 3
tei: 0.6739 @epoch 1
```

1.11.2 Visual Representation

This sections provides a more visual representation of results and comparative data

[4]:
```
vis.display_synth_data()
```

[5]:
```
vis.display_metrics()
```



1.11.3 Observations

The graphs above help visualize the performances of the various GAN models with both oracle and real training. Each of our 3 models seemed to perform much better than TextGan in the NLL-Test with both Oracle and real training, as well as under the Embedding Similarity metric with