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Submission includes a report, run.py, score.py, 'TrainGAN' ipynb file for code inspection and results visualization. Generated models, losses and scores during training are saved under the 'logs' folder.

1. **Problem definition (X as training data and Z as noise data)**
   - Train a GAN from lung cells images to fulfill these 3 criteria:
     - S1: D gives high score for original data
     - S2: G(z) images are close to the boundary of X
     - S3: Generated data needs to be similar to one of X

2. **Method**
   - Train a GAN as usual with binary cross entropy losses on both discriminator and generator
   - S1 and S3 are accounted from the discriminator and generator's default BCE loss function
   - (Define S2 as boundary loss) For S2, change discriminator loss function from noise data Z as follow: $D_{loss} = -\left[y_1 * \log\left(D(x)\right) + \gamma * (1 - y_2) * \log\left(1 - 4\left(D\left(G(x)\right) - 0.5\right)^2\right)\right], where\ y_1 = 1\ and\ y_2 = 0$
   - Add a hyperparameter $0 < \gamma < 1$ to the 2nd term of D's loss function for tuning purposes
   - Train the GAN with high epoch, terminate when s1, s2 and s3 generate high values

3. **Results**
   - The results of original GAN vs modified GAN is shown in figure 1 where s2 (red line) improves drastically while s1 and s3 remain the same in the first few epochs.

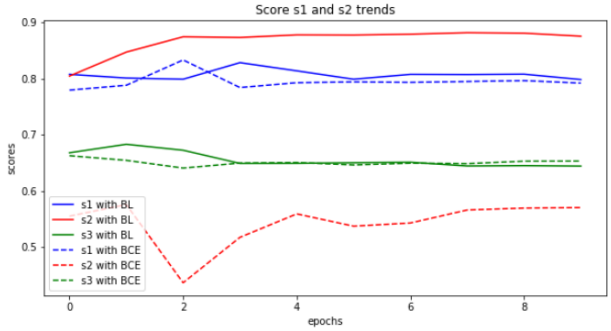

Figure 1 Results comparison between original GAN (dotted lines) vs modified GAN (solid lines)

BL: Boundary loss (S2 criteria)

BCE: Binary cross entropy loss

   - Optimal value for γ is 0.8 after tuning
   - After training with higher epochs, G and D losses reduced drastically and oscillates between 0 to 1
   - After 60 epochs, s1 and s2 reached its optimal value of 0.9983 and 0.999 respectively (score history for s3 wasn't tracked due to longer computational time for s3)
   - Best results obtained from given data:

```
{'s1': 0.9982962608337402, 's2': 0.9999310374259949, 's3': 0.6801146268844604, 'score': 0.6789090664113528}
```