**Table 1.** Deep Learning algorithms reviewed in the paper

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **App** | **Algorithm** | **Models** | | **Evaluation** | **Environment** | | | | **Codes** | **Refs** |
| **Imputation** | | | | | | | | | | |
|  | DCA | AE | | DREMI | Keras, Tensorflow, scanpy | | | | <https://github.com/theislab/dca> | [17] |
|  | SAVER-X | AE+TL | | t-SNE, ARI | R/sctransfer | | | | <https://github.com/jingshuw/SAVERX> | [51] |
|  | DeepImpute | DNN | | MSE, Pearson’s correlation | Keras/Tensorflow | | | | <https://github.com/lanagarmire/DeepImpute> | [19] |
|  | LATE | AE | | MSE | Tensorflow | | | | <https://github.com/audreyqyfu/LATE> | [52] |
|  | scGAMI | AE | | NMI, ARI, HS and CS | Tensorflow | | | | <https://github.com/QUST-AIBBDRC/scGMAI/> | [53] |
|  | scIGANs | GAN | | ARI, ACC, AUC, and F-score | PyTorch | | | | <https://github.com/xuyungang/scIGANs> | [18] |
| **Batch correction** | | | | | | | | | | |
|  | BERMUDA | AE+TL | | kBET, entropy of Mixing, SI | PyTorch | | | | <https://github.com/txWang/BERMUDA> | [57] |
|  | DESC | AE | | ARI, KL | Tensorflow | | | | <https://github.com/eleozzr/desc> | [61] |
|  | iMAP | AE+GAN | | kBET, LISI | PyTorch | | | | <https://github.com/Svvord/iMAP> | [64] |
| **Clustering, latent representation, dimension reduction, and data augmentation** | | | | | | | | | | |
|  | Dhaka | VAE | | ARI, Spearman Correlation | Keras/Tensorflow | | | | <https://github.com/MicrosoftGenomics/Dhaka> | [66] |
|  | scvis | VAE | | KNN preservation, log-likelihood | Tensorflow | | | | <https://bitbucket.org/jerry00/scvis-dev/src/master/> | [69] |
|  | scVAE | VAE | | ARI | Tensorflow | | | | <https://github.com/scvae/scvae> | [70] |
|  | VASC | VAE | | NMI, ARI, HS, and CS | H5py, keras | | | | <https://github.com/wang-research/VASC> | [71] |
|  | scDeepCluster | AE | | ARI, NMI, clustering accuracy | Keras, Scanpy | | | | <https://github.com/ttgump/scDeepCluster> | [73] |
|  | cscGAN | GAN | | t-SNE, marker genes, MMD, AUC | Scipy, Tensorflow | | | | <https://github.com/imsb-uke/scGAN> | [76] |
| **Multi-functional models** (IM: imputation, BC: batch correction, CL: clustering) | | | | | | | | | | |
|  | scVI | VAE | | **IM**: L1 distance; **CL**: ARI, NMI, SI**; BC**: Entropy of Mixing | PyTorch, Anndata | | | | <https://github.com/YosefLab/scvi-tools> | [16] |
|  | LDVAE | VAE | | Reconstruction errors | Part of scVI | | | | <https://github.com/YosefLab/scvi-tools> | [80] |
|  | SAUCIE | AE | | **IM**: R2 statistics; **CL**: SI**;  BC**: modified kBET; Visualization: Precision/Recall | Tensorflow | | | | <https://github.com/KrishnaswamyLab/SAUCIE/> | [14] |
|  | scScope | AE | | **IM**:Reconstruction errors**;  BC**: Entropy of mixing**; CL**: ARI | Tensorflow, Scikit-learn | | | | <https://github.com/AltschulerWu-Lab/scScope> | [86] |
| **Cell type Identification** | | | | | | | | | | |
|  | DigitalDLSorter | DNN | Pearson correlation | | | R/Python/Keras | | <https://github.com/cartof/digitalDLSorter> | | [87] |
|  | scCapsNet | CapsNet | Cell-type Prediction accuracy | | | Keras, Tensorflow | | <https://github.com/wanglf19/scCaps> | | [94] |
|  | netAE | VAE | Cell-type Prediction accuracy, t-SNE for visualization | | | pyTorch | | <https://github.com/LeoZDong/netAE> | | [98] |
|  | scDGN | DANN | Prediciton accuracy | | | pyTorch | | <https://github.com/SongweiGe/scDGN> | | [101] |
|  |  |  |  | | |  | | | |  |
| **Function analysis** | | | | | | | | | | |
|  | CNNC | CNN | AUROC, AUPRC, and accuracy | | | | Keras, Tensorflow | <https://github.com/xiaoyeye/CNNC> | | [104] |
|  | scGen | VAE | Correlation, visualization | | | | Tensorflow | <https://github.com/theislab/scgen> | | [113] |

DL Model keywords: AE: autoencoder, AE+TL: autoencoder with transfer learning, AE: variational autoencoder, GAN: Generative adversarial network, CNN: convolutional neural network, DNN: deep neural network, DANN: domain adversarial neural network, CapsNet: capsule neural network