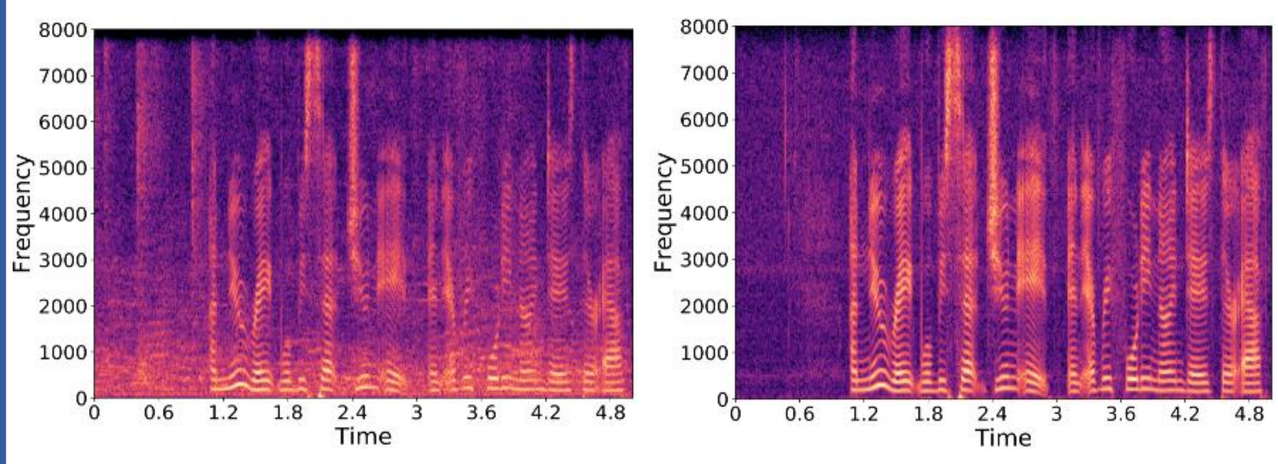
#14 Speech Enhancement with Cycle-Consistent Neural Networks

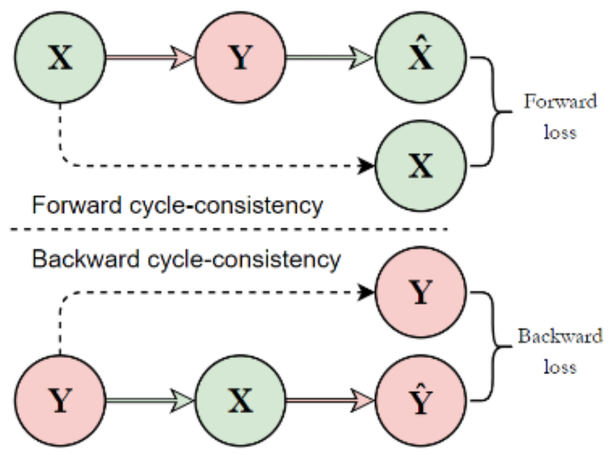
Motivation

- Noise in speech recordings reduces the effectiveness of Automatic Speech Recognition (ASR) systems
- State-of-the-art speech enhancement systems use neural networks to remove noise
- Neural network models can further be strengthened by employing **cycle-consistency constraint**



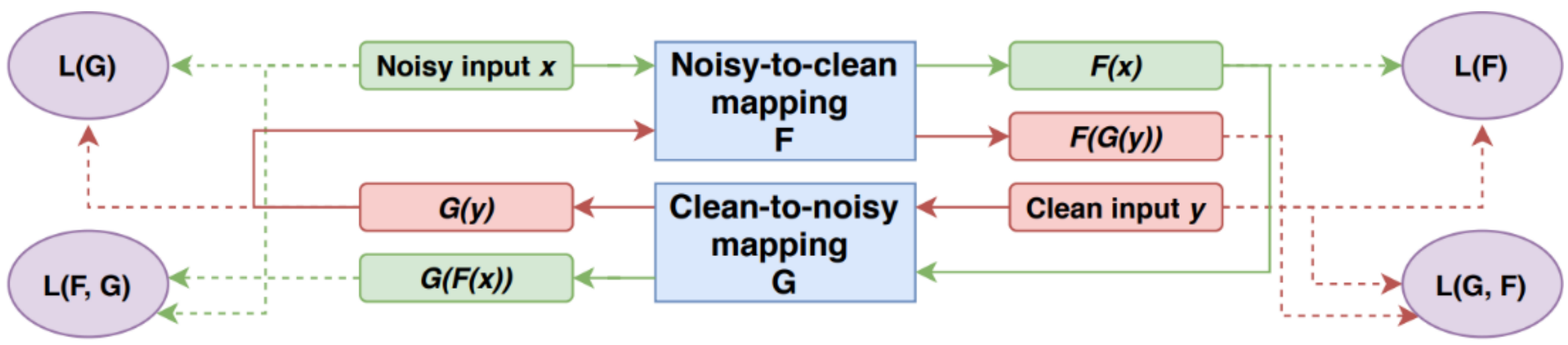
Cycle-Consistent Neural Network

- Uses a **second** neural network with the **opposite** goal during training
- First, the noisy speech signal is enhanced using a neural network
- Then, then noise is inserted back to that enhanced speech signal using the second network **(forward cycle-consistency)** or vice versa **(backward cycle-consistency)**
- The networks are pre-trained separately
- After initialization, they are trained simultaneously with the use of cycle-consistency losses



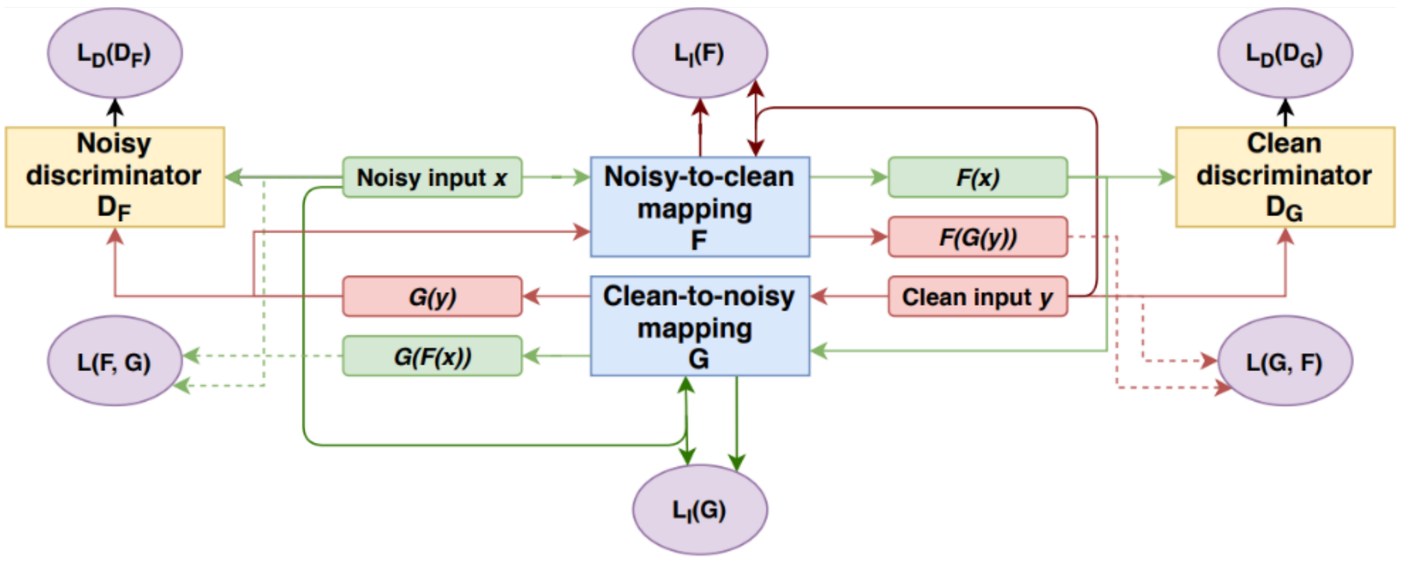
Results

Model	WER (%)	Improvement (%)
None	27.70	-
Baseline	22.88	17.40
FW	22.65	18.23
FW+BW	**21.89**	**20.97**



Cycle-Consistent GAN

- Sometimes it can be difficult to have a specific dataset of input-label pairs
- Generative Adversarial Networks (GANs) can be used to train model with unpaired data
- We coupled GAN with cycle-consistency and identity-mapping constraints for adversarial speech enhancement



Results

Model	WER (%)	Improvement (%)
None	27.70	-
GAN	24.18	12.10

Acoustic model re-training

- We further re-trained acoustic models with data enhanced using trained models to obtain even better results

Results

Model	Acoustic model	WER (%)	Improvement (%)
None	Clean	27.70	-
FW+BW	Clean	21.89	20.97
FW+BW	**FW+BW**	**18.42**	**33.50**
GAN	Noisy	24.18	12.10
GAN	**GAN**	**14.72**	**48.86**

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