TreeGCN-ED : A Point Cloud Encoder-Decoder Network

- Graph Convolution

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A : Adjacency Matrix

U : Feature Matrix

W : Weight Matrix/ Filter

F_i : Number of features at the ith layer of network

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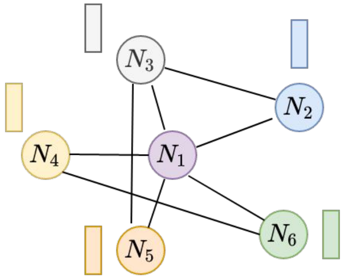

	N_1	N_2	N_3	N_4	N_5	N_6
N_1	0	1	1	1	1	1
N_2	1	0	1	0	0	0
N_3	1	1	0	0	1	0
N_4	1	0	0	0	0	1
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N_6	1	0	0	1	0	0

A

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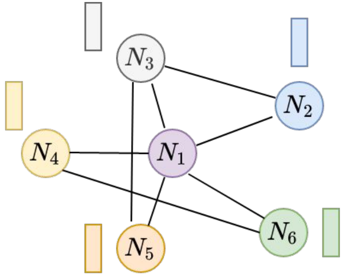

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A

N_1	x_1	y_1	z_1
N_2	x_2	y_2	z_2
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N_4	x_4	y_4	z_4
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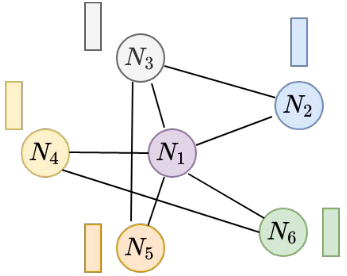

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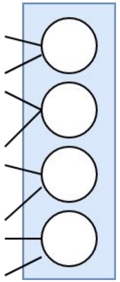
U

w_1	w_2	w_3	w_4
w_5	w_6	w_7	w_8
w_9	w_{10}	w_{11}	w_{12}

W



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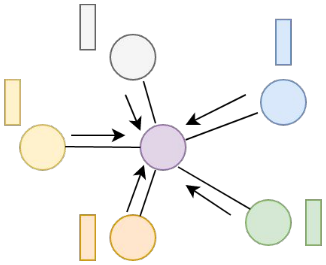

Feature Gathering

$$A_{N\times N} \times U_{N\times F^i}$$

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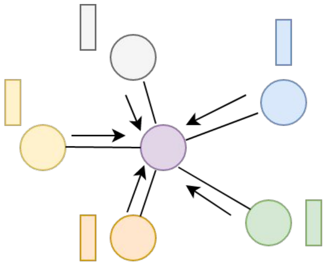

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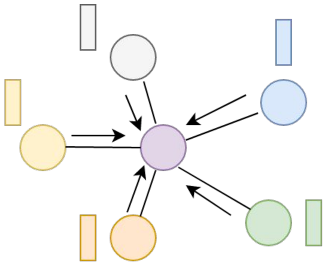

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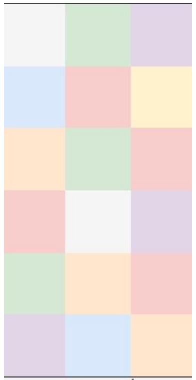

$N \times F^i$

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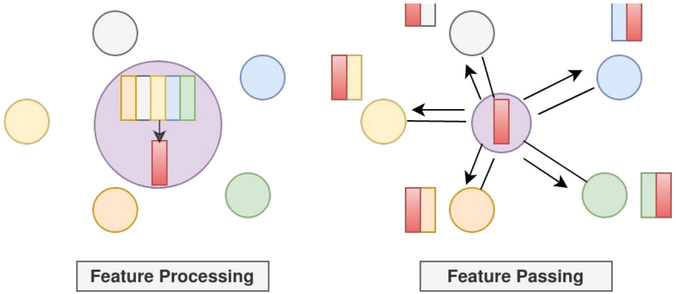

$$U'_{N\times F^i} \times W_{F^i\times F^{i+1}}$$

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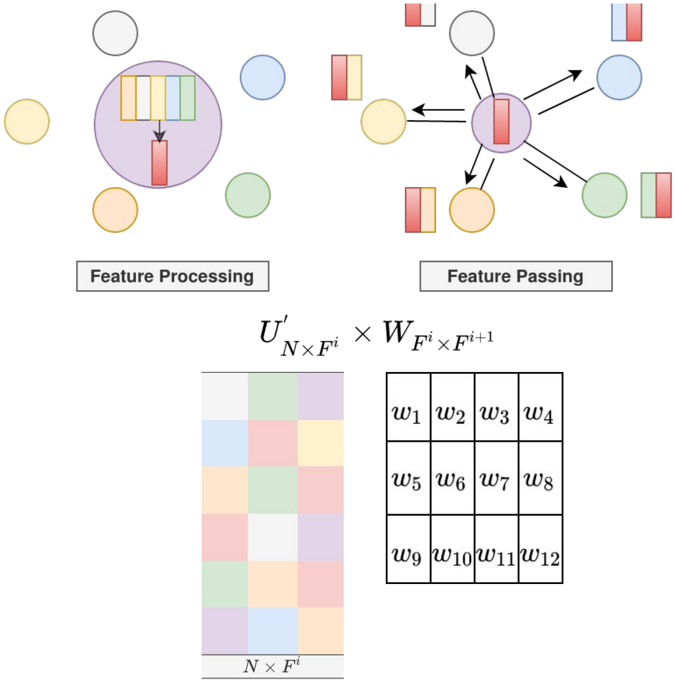

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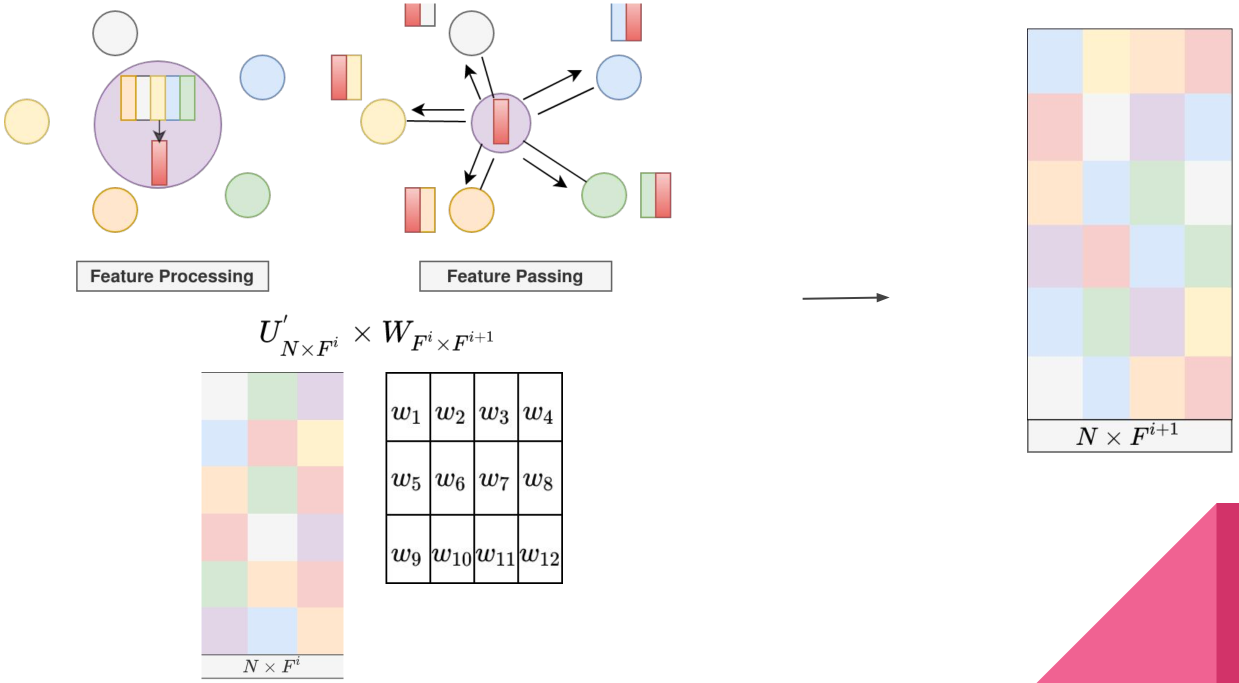

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$$F^{i+1} = \sigma(A_{N \times N} U_{N \times F^i} W^i_{F^i \times F^{i+1}})$$

Here $\boldsymbol{\sigma}$ is non-linearity in the network. It can be relu, leaky-relu, sigmoid e.t.c. For our work we have considered leaky-relu function.

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- Chamfer Distance
  - It measures the distance between two point set.
  - In our case point set contains distinct tuple values which represent (x, y, z) coordinates of 3D point cloud shape. Ex: S1 = {(xi, yi, zi)} and S2 = {(x'j, y'j, z'j)}

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$$\mathcal{L}_{chamfer}(S_1, S_2) = \sum_{x \in S_1} min_{y \in S_2} ||x - y||_2^2 + \sum_{y \in S_2} min_{x \in S_1} ||x - y||_2^2$$

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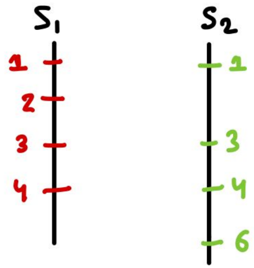
Ex: S1 = {1, 2, 3, 4} and S2 = {3, 4, 1, 6}



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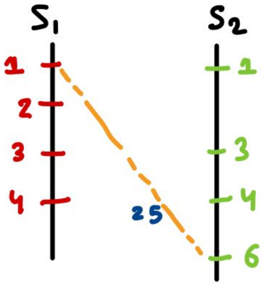

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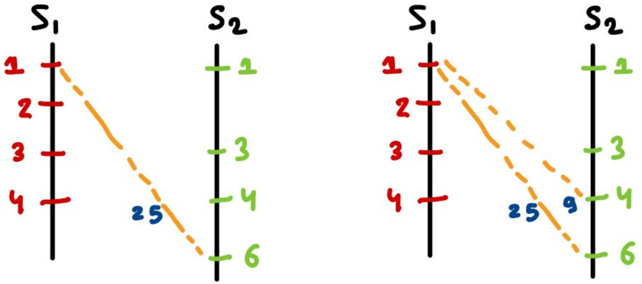

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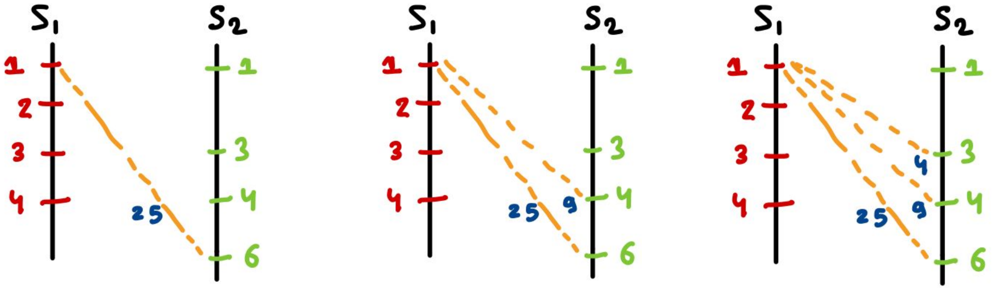

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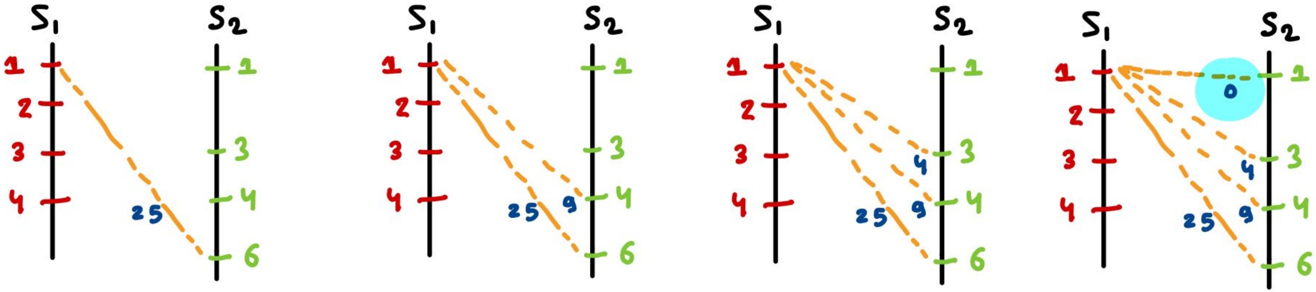

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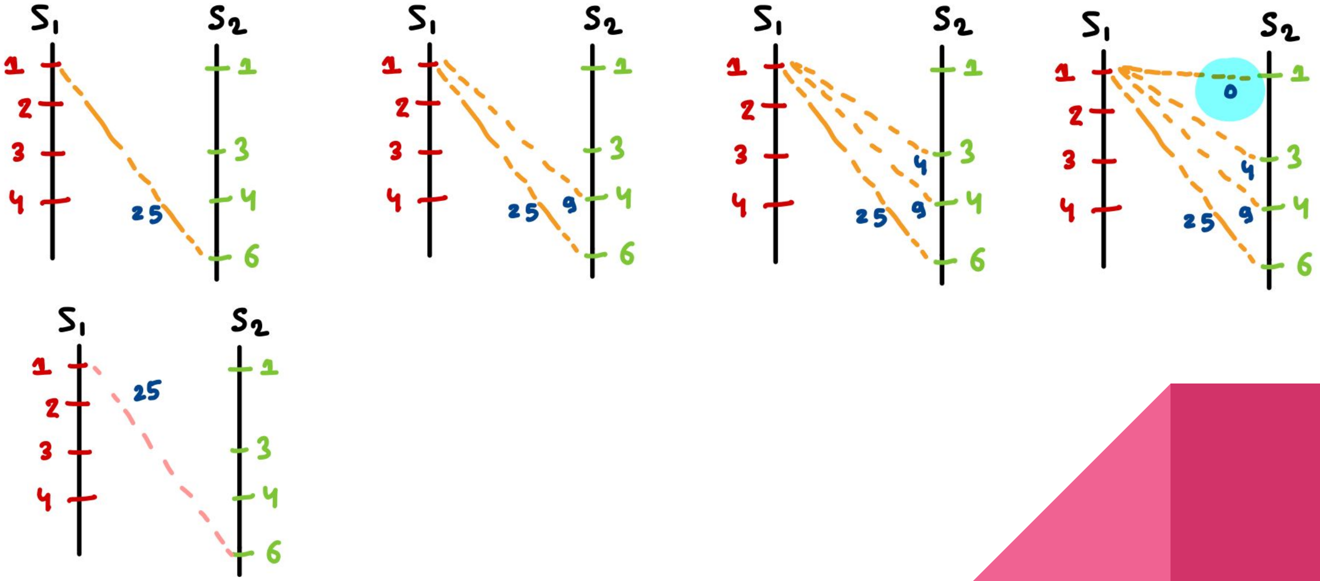

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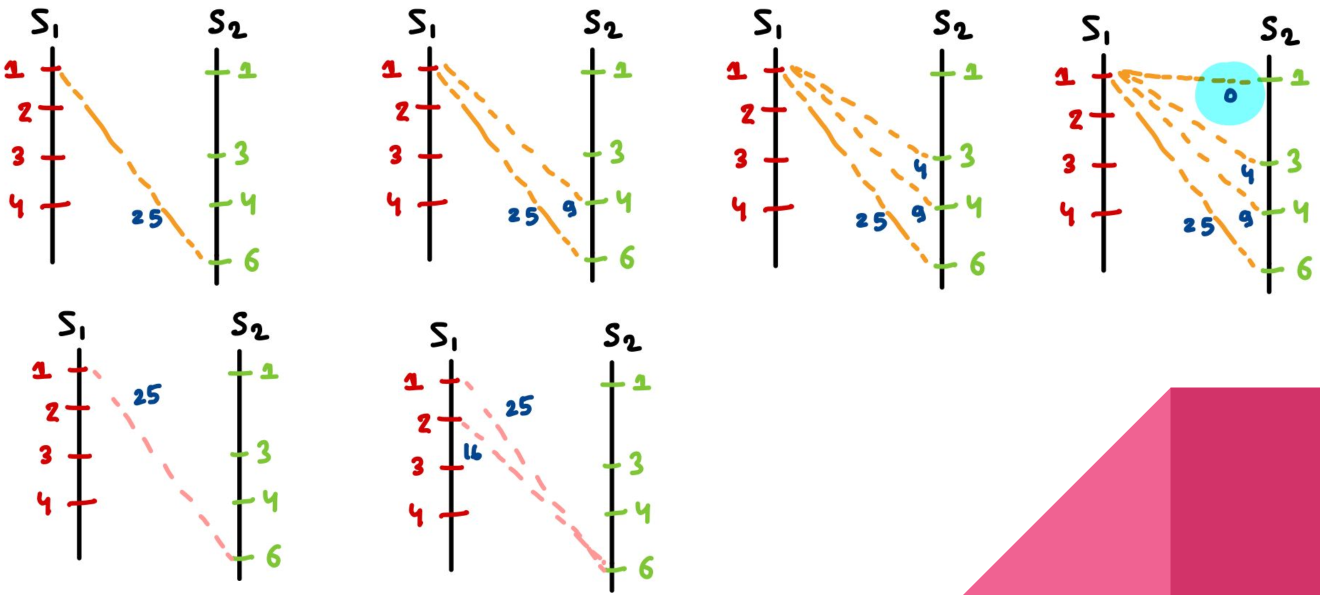

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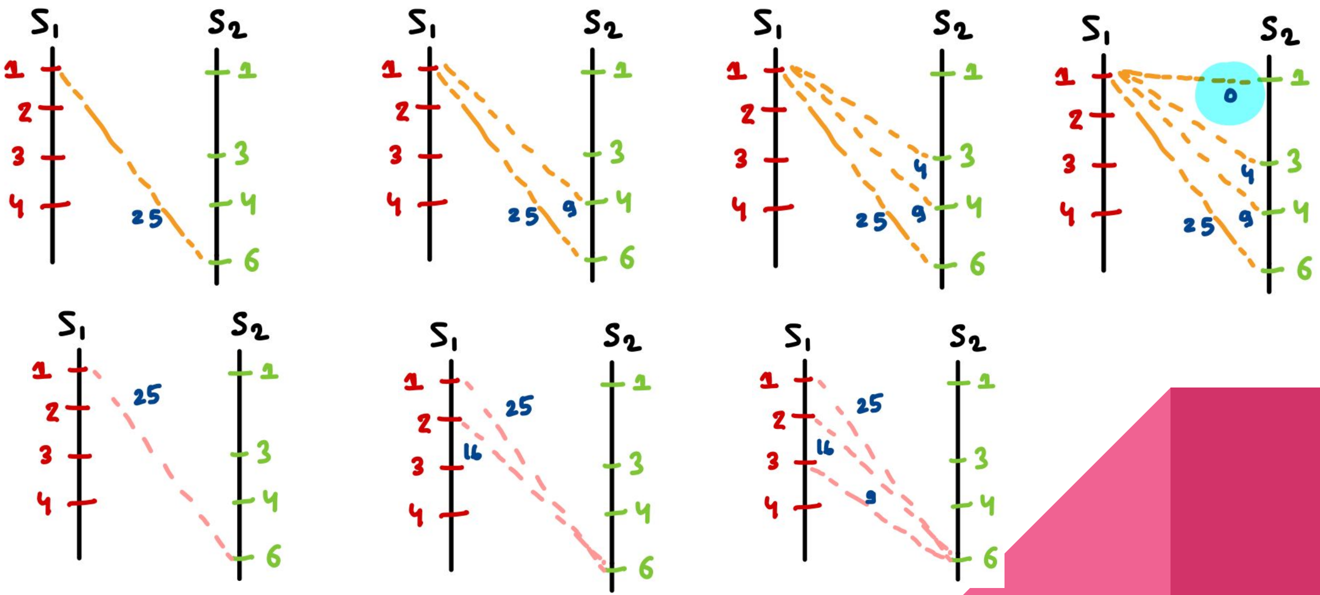

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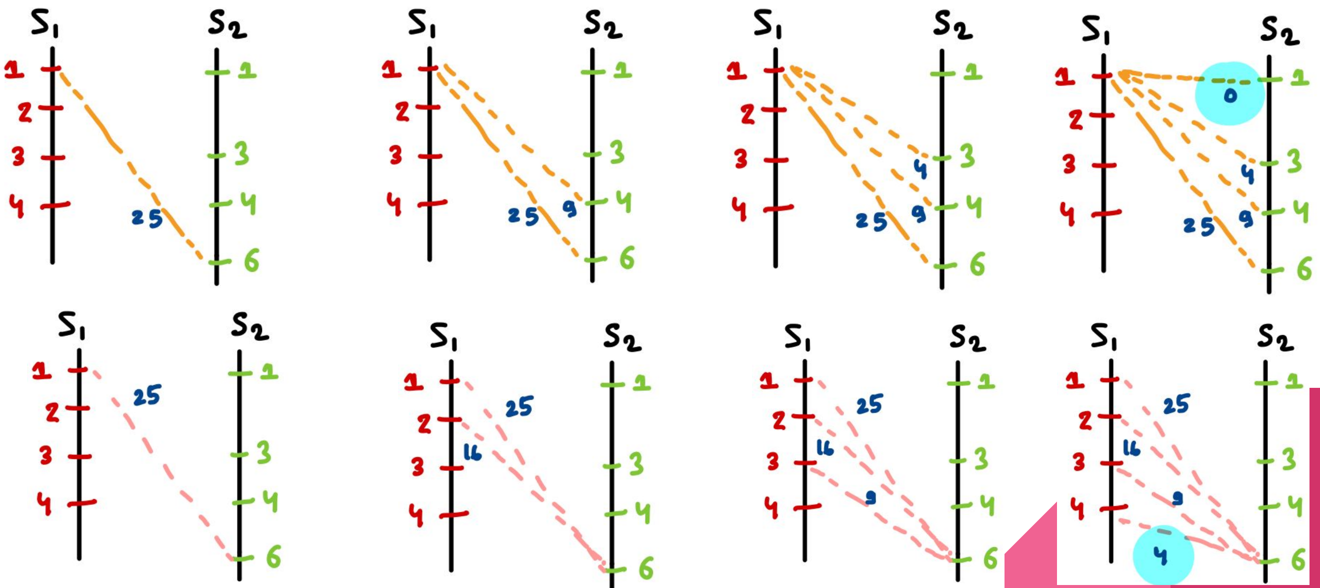

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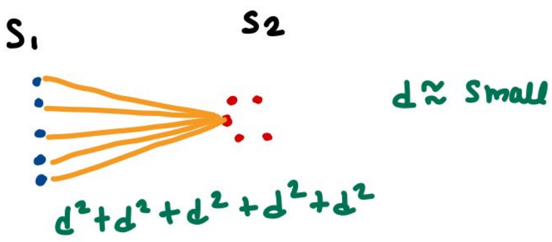

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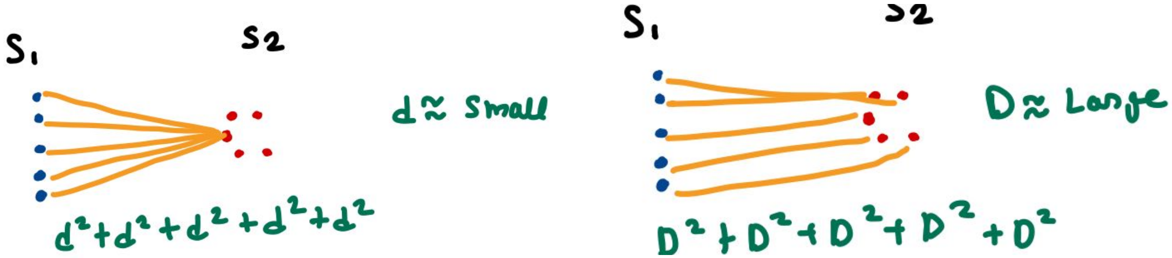

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- Frechet Inception Distance [3] and Frechet Point Cloud [1]
  - FID is use to evaluate the quality of target image with respect to reference image.
  - FPD is use to evaluate the quality of target point cloud with respect to reference point cloud.
  - These both are the metrics for evaluation and comparison of the deep learning models.
  - We use FID in image generation GAN to evaluate the quality of image generated by the GAN model.
  - Idea of FPD is first proposed is TreeGCN-GAN [1] paper.

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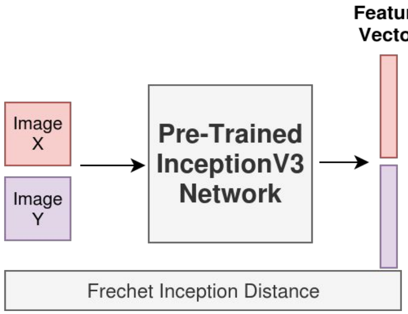

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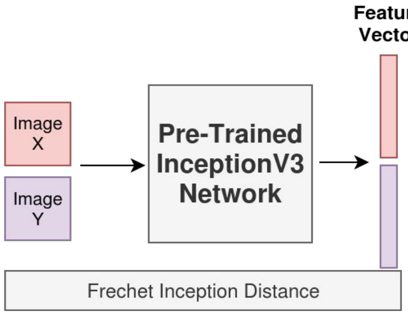

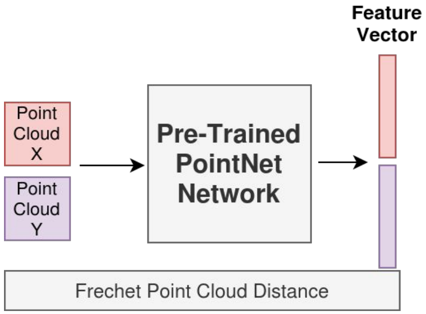

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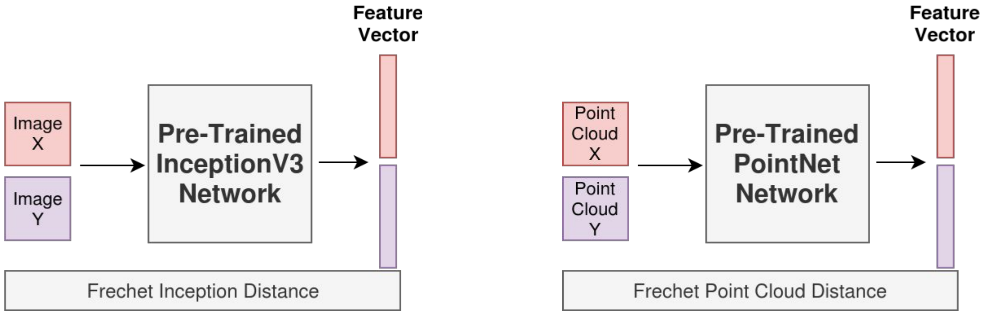

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  - Lower the Frechet Distance better the generated result is.

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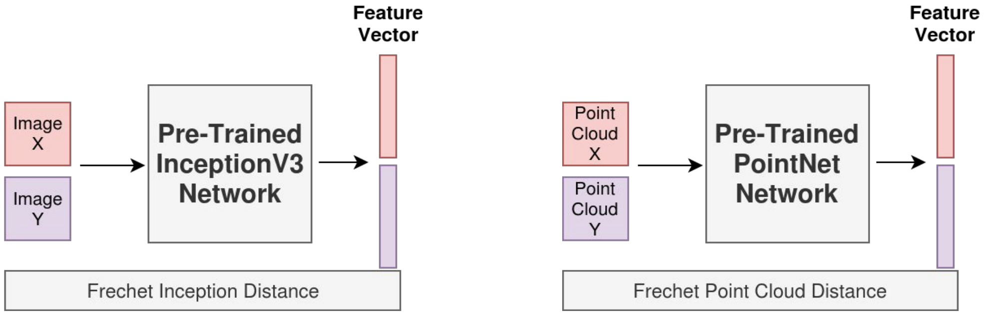

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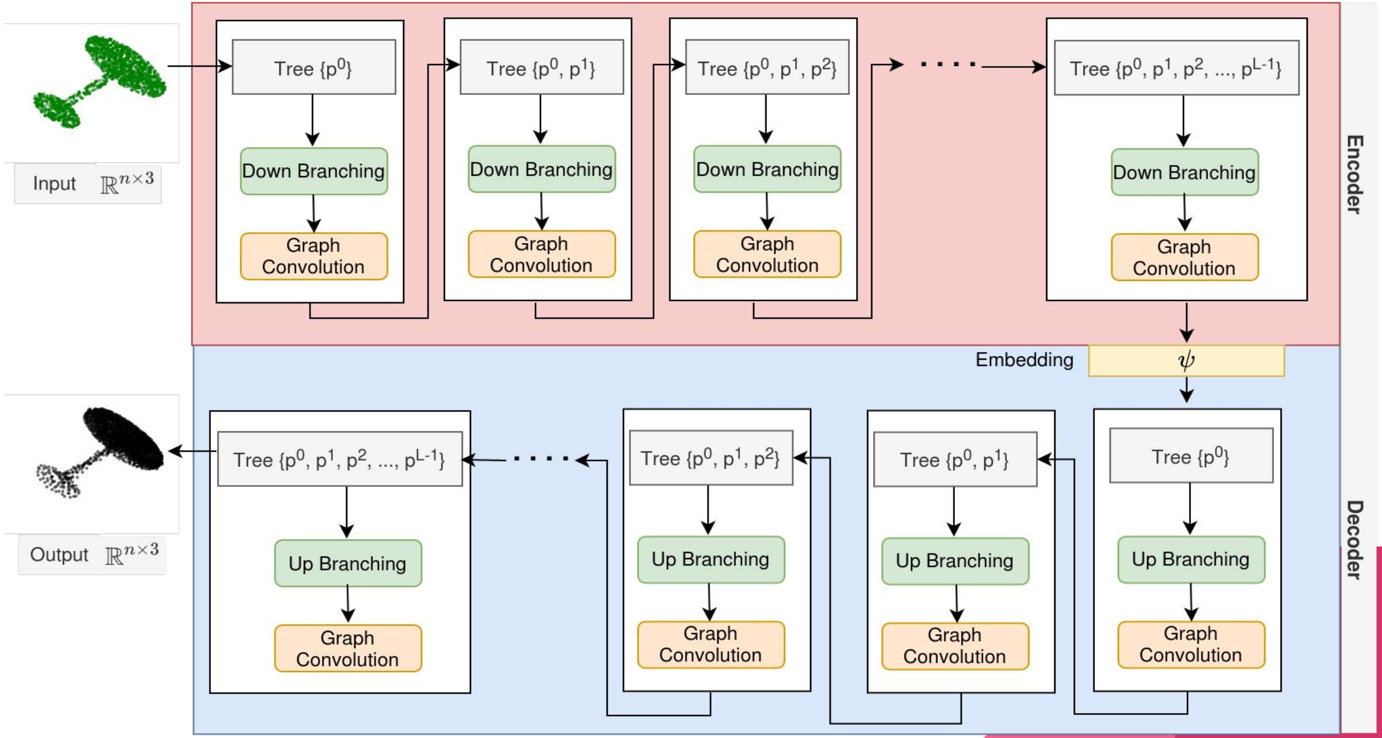
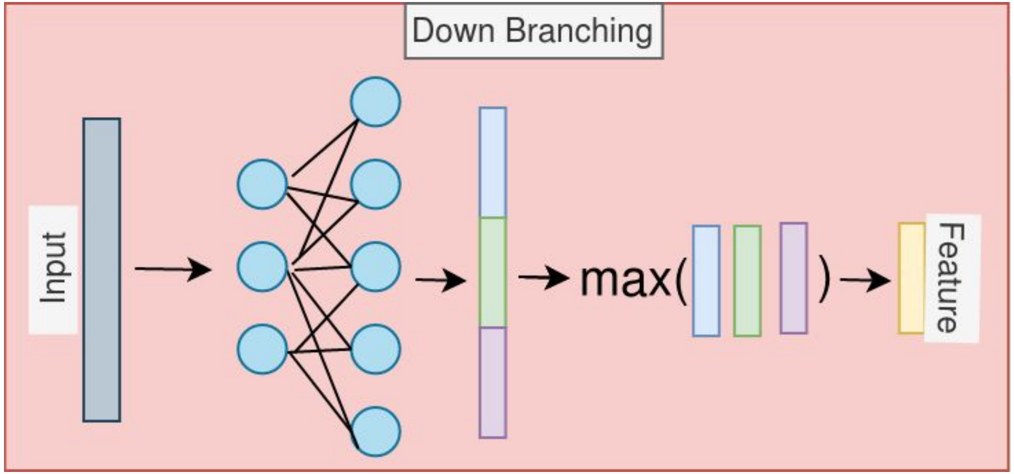
- Proposed TreeGCN-ED Model



TreeGCN-ED : A Point Cloud Encoder-Decoder Network

- Proposed TreeGCN-ED Model
  - Down Branching



TreeGCN-ED : A Point Cloud Encoder-Decoder Network

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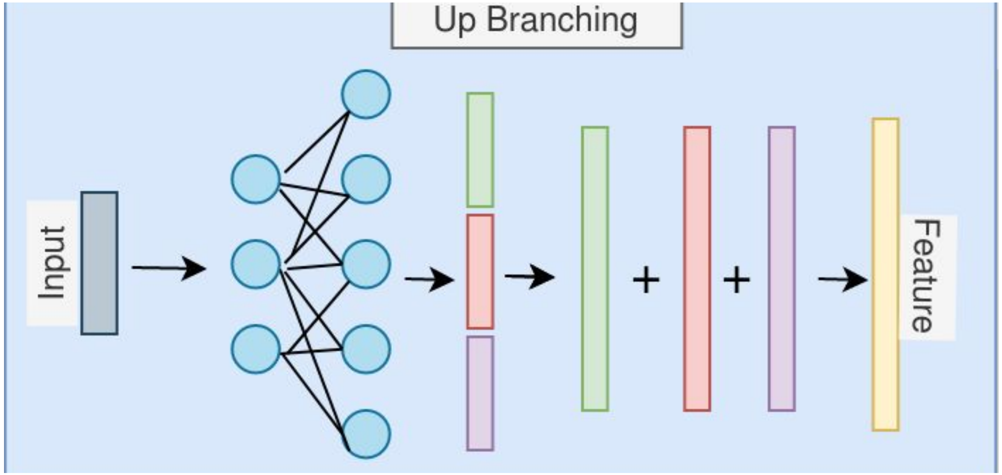
  - Up Branching



TreeGCN-ED : A Point Cloud Encoder-Decoder Network

- Loss Function
    - Chamfer distance function is used to train complete TreeGCN-ED model.
- Dataset
    - ShapenetBenchmarkV0 [5]
    - Specifically we trained our model on 2 classes [chair and table]

[5] Shapnet Dataset [https://arxiv.org/abs/1512.03012]

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TreeGCN-ED : A Point Cloud Encoder-Decoder Network

- Result and Comparison
  - Quantitative Results

Class	Models	CD	FPD
Table	PointNet-ED [6]	20.89	11849.31
	FoldingNet [7]	0.93	26.04
	TreeGCN-ED	**0.70**	**11.77**
Chair	PointNet-ED [6]	12.25	3810.69
	FoldingNet [7]	0.99	17.64
	TreeGCN-ED	**0.76**	**7.60**

[6] Pointnet [https://arxiv.org/abs/1612.00593] [7] FoldingNet [https://arxiv.org/abs/1712.07262]

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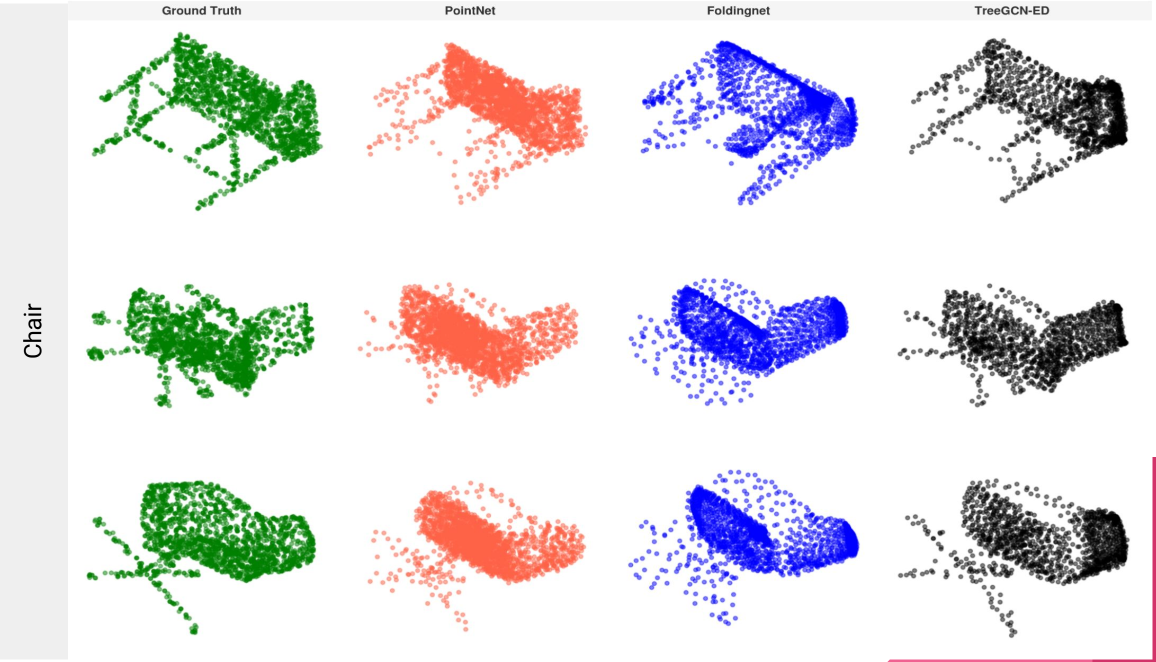

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