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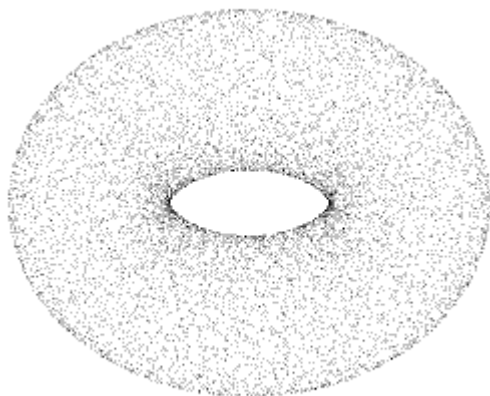
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Deep Learning on Point Cloud of Aerospace Components for 3D Classification

Background



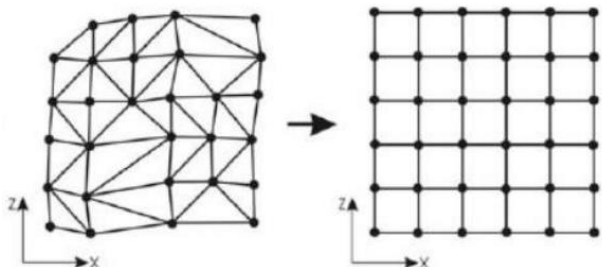
Point Cloud



an set of data points in space

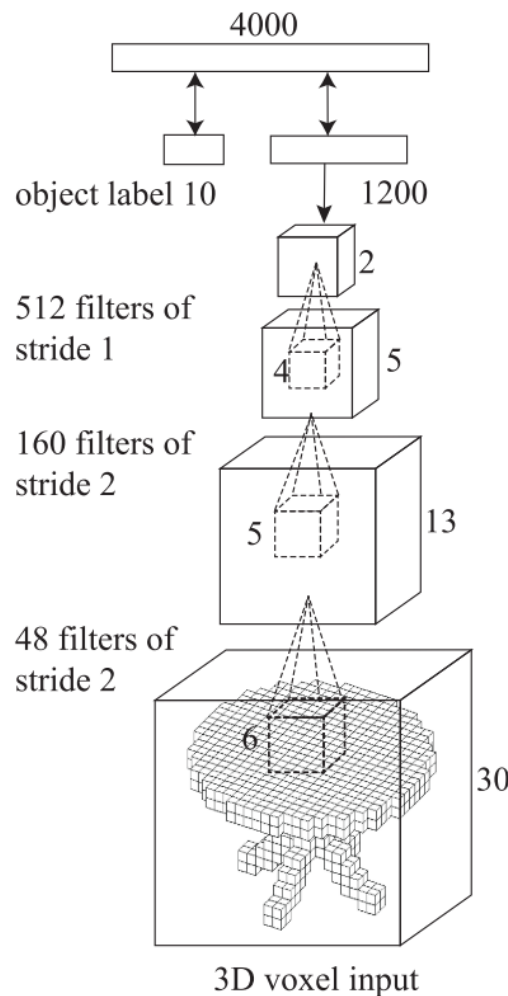
$$\{P_i \mid i = 1, \dots, n\}$$

where $P_i = (x, y, z, R, G, B\dots)$

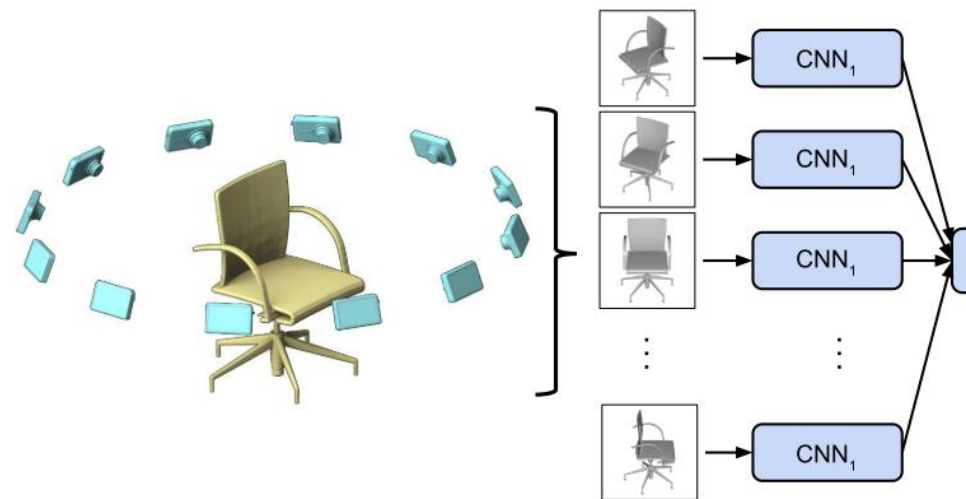


unordered
irregular
format

Volumetric CNN



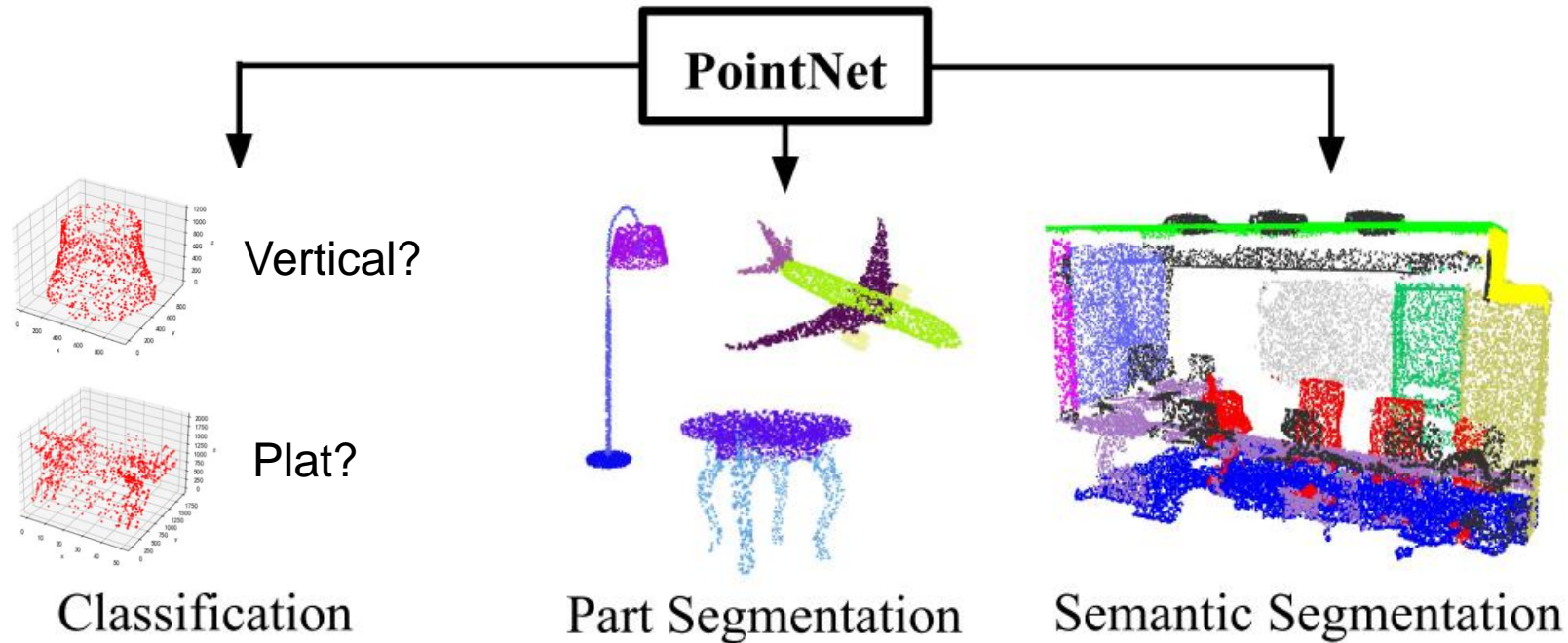
Multi-View



- unnecessary computation **cost**
- data **sparsity**
- **only** shape classification

Introduction

simple, efficient and effective approach



Problems

- set of vectors \longleftrightarrow images, sequences, volumes
- natural invariance, unordered $n!$ permutations
- invariance under rigid transformations
- robust to perturbation

Approaches

- symmetry function
- mini-net for affine matrix

Symmetry Function



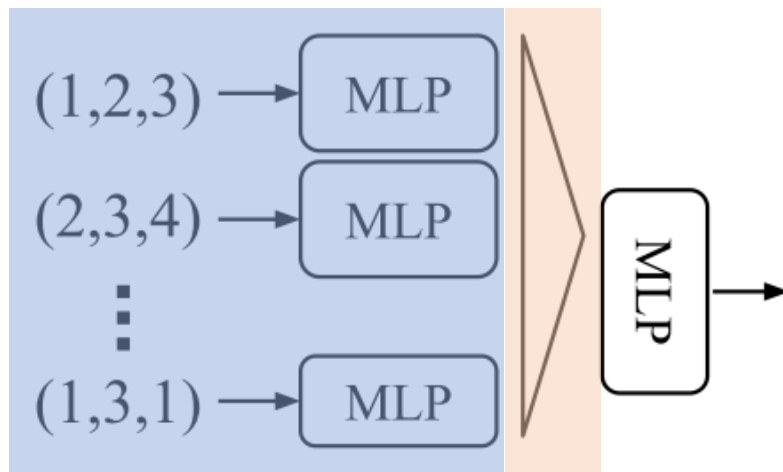
invariant to input permutation

Multi-Layer Perceptron



Max Pooling

$$\underbrace{\mathbb{R}^K \times \dots \times \mathbb{R}^K}_n \rightarrow \mathbb{R}$$



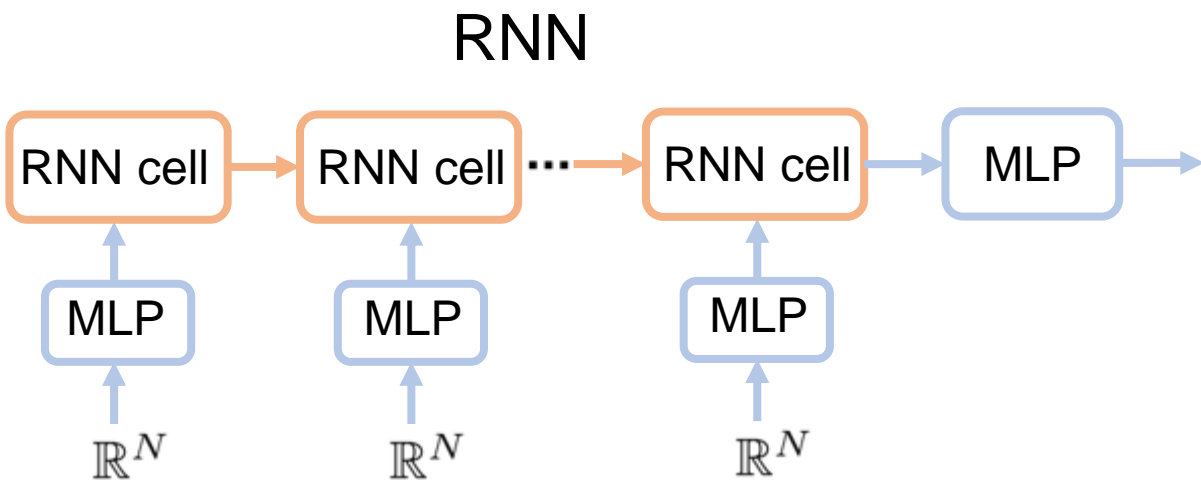
critical points

skeleton of objects

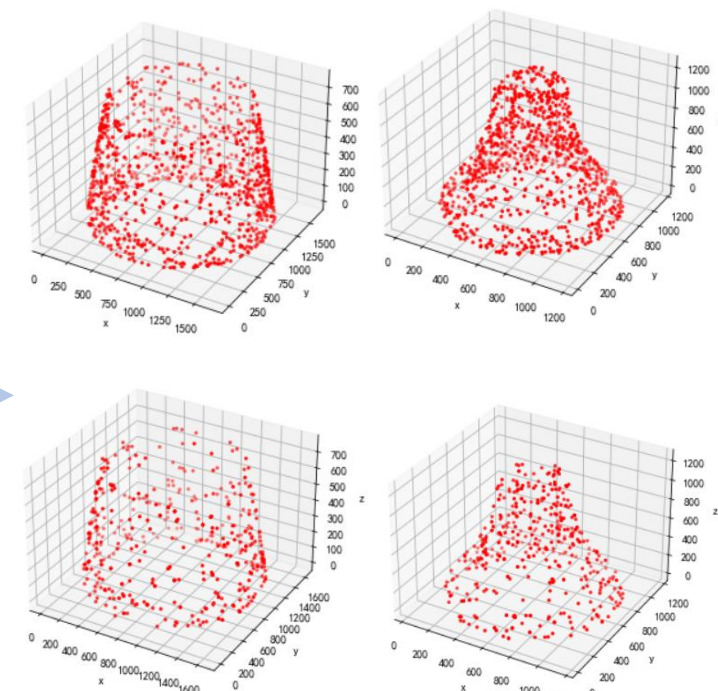
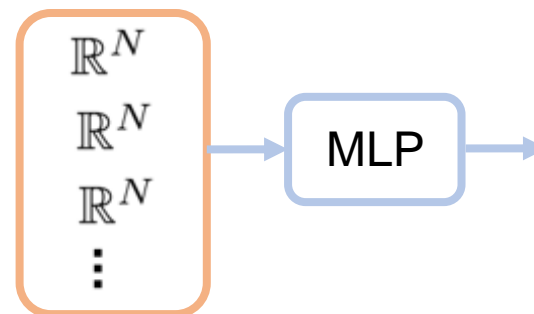


robust

(outliers, missing data...)



sorted



Mini-net for Alignment

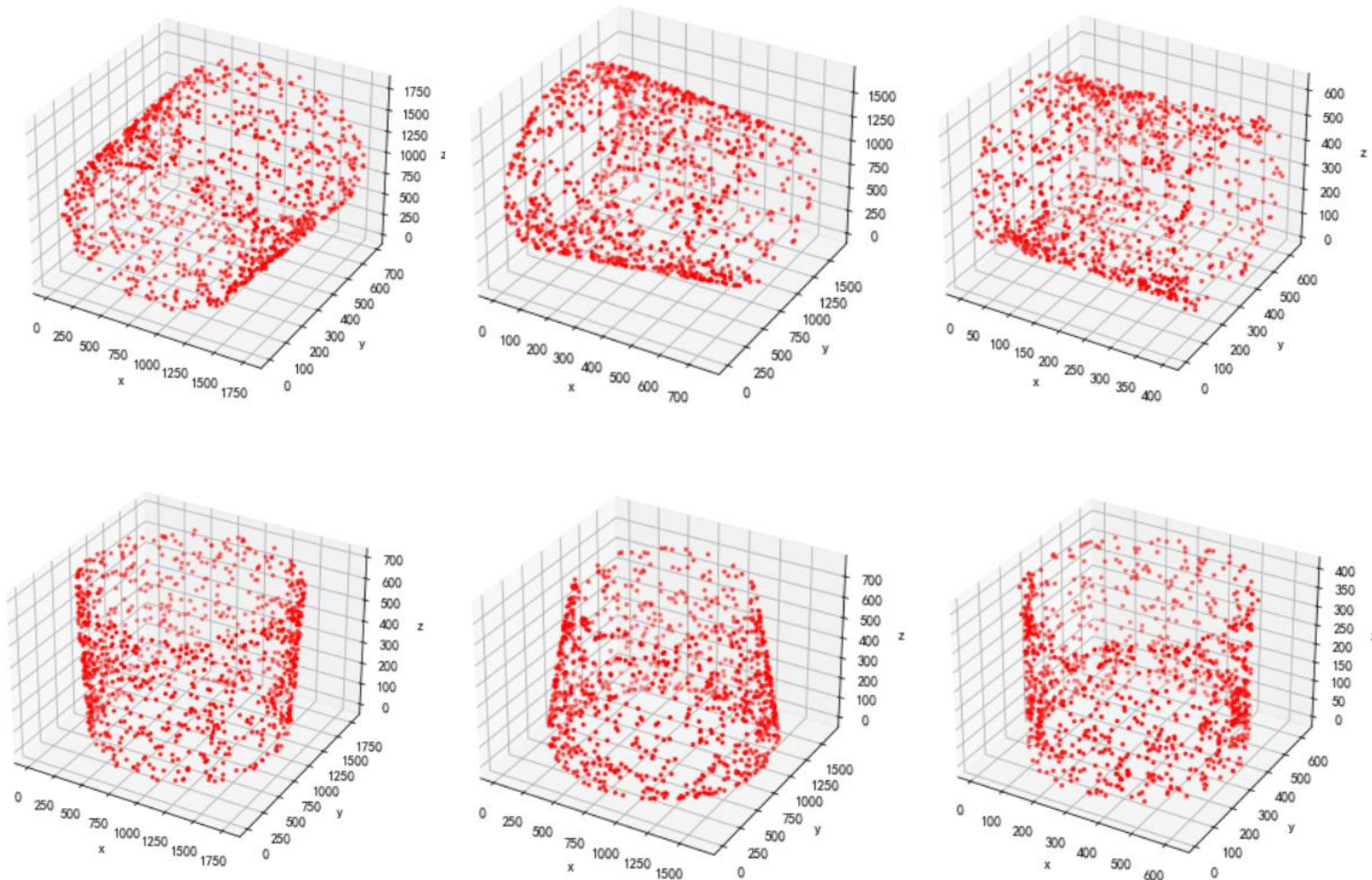


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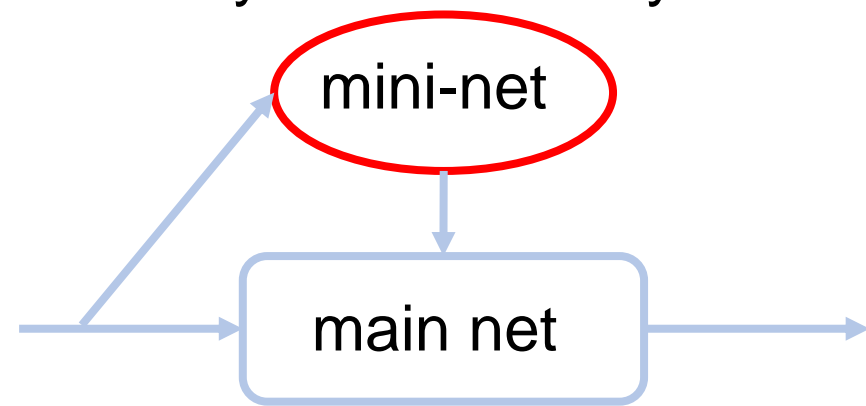
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affine transformation matrix



resemble big network

- point independent feature extraction
- max pooling
- fully connected layers



$$L_{reg} = \|I - AA^T\|_F^2,$$

Regularization

close to **orthogonal** matrix

Experiment Details

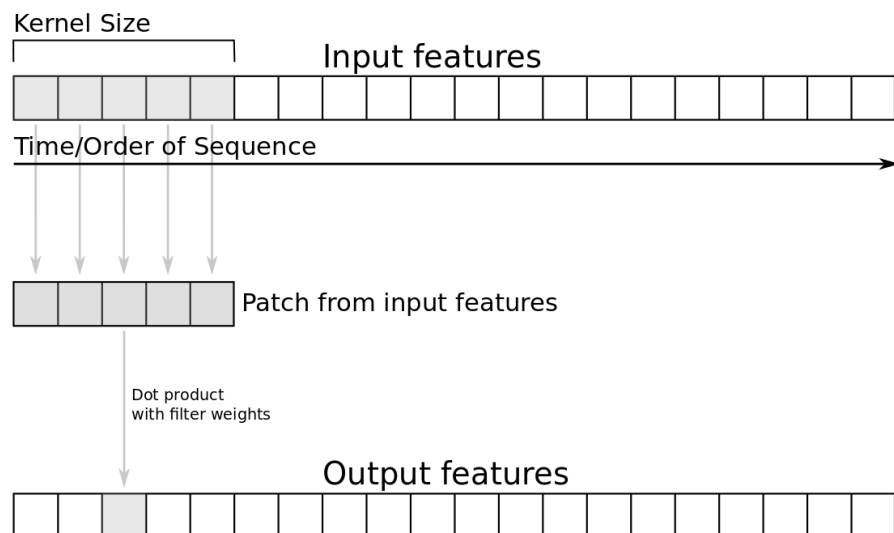


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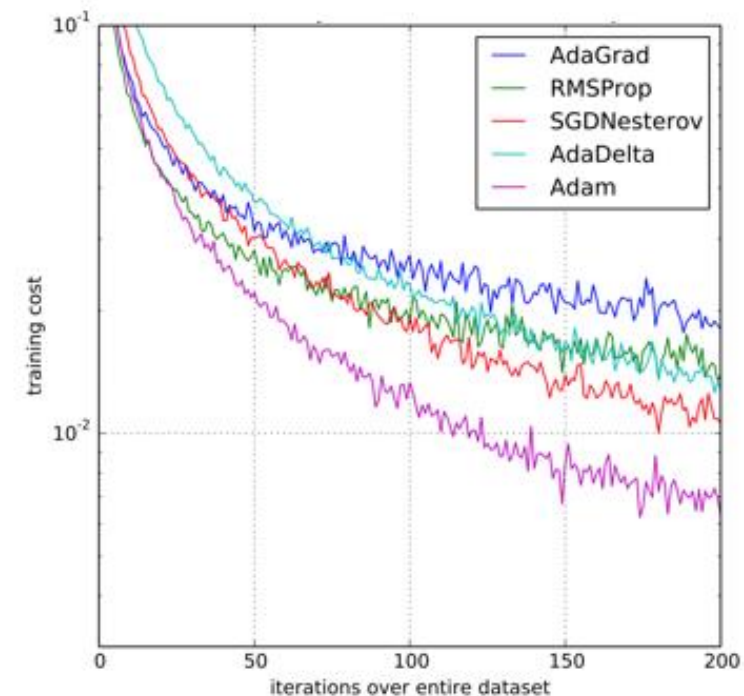


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1. conv1d

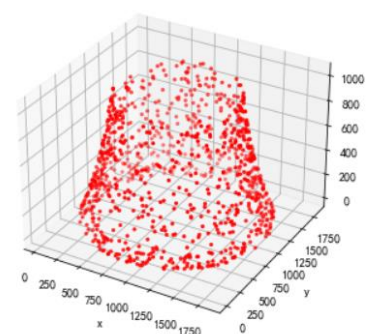


2. optimizer Adam

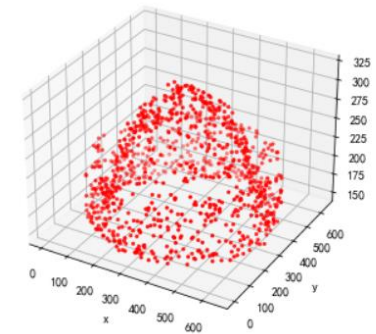


3. dataset

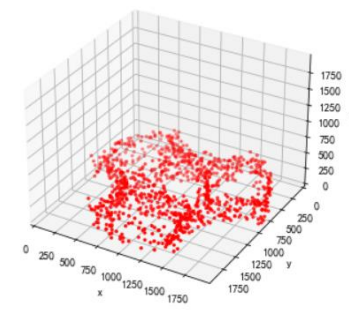
	vertical	cap	plat
total	80	80	80
train	60	60	60
test	20	20	20



vertical



cap



plat

Results and Analysis



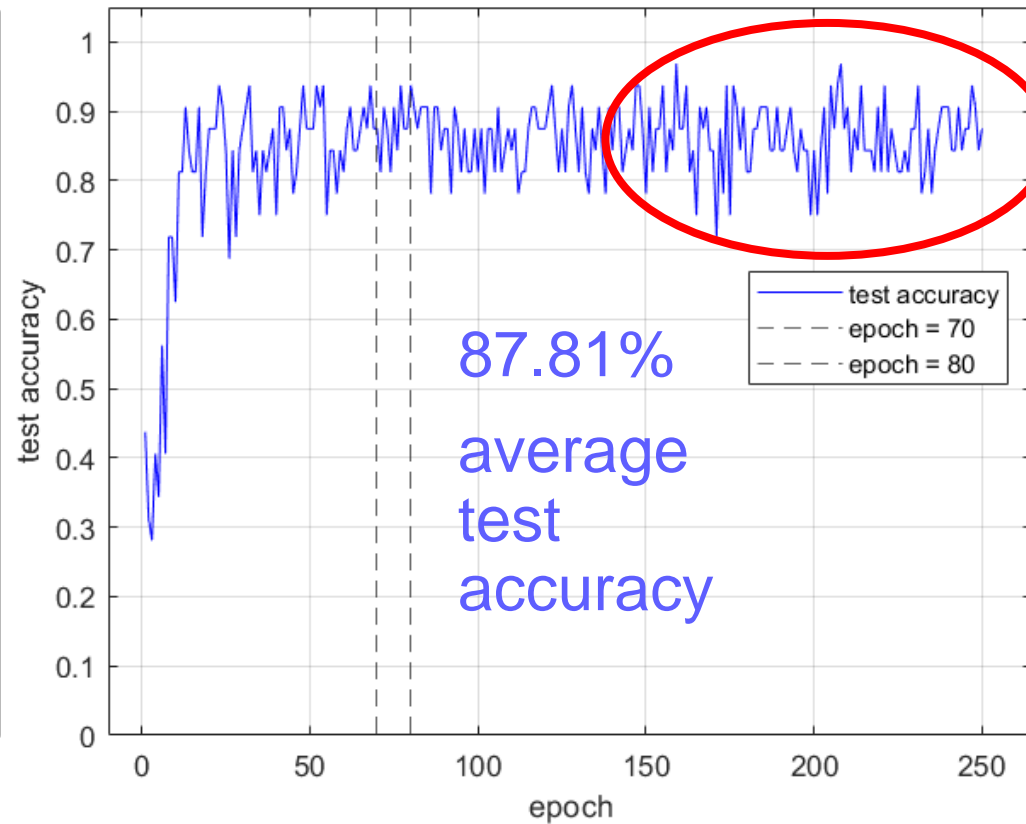
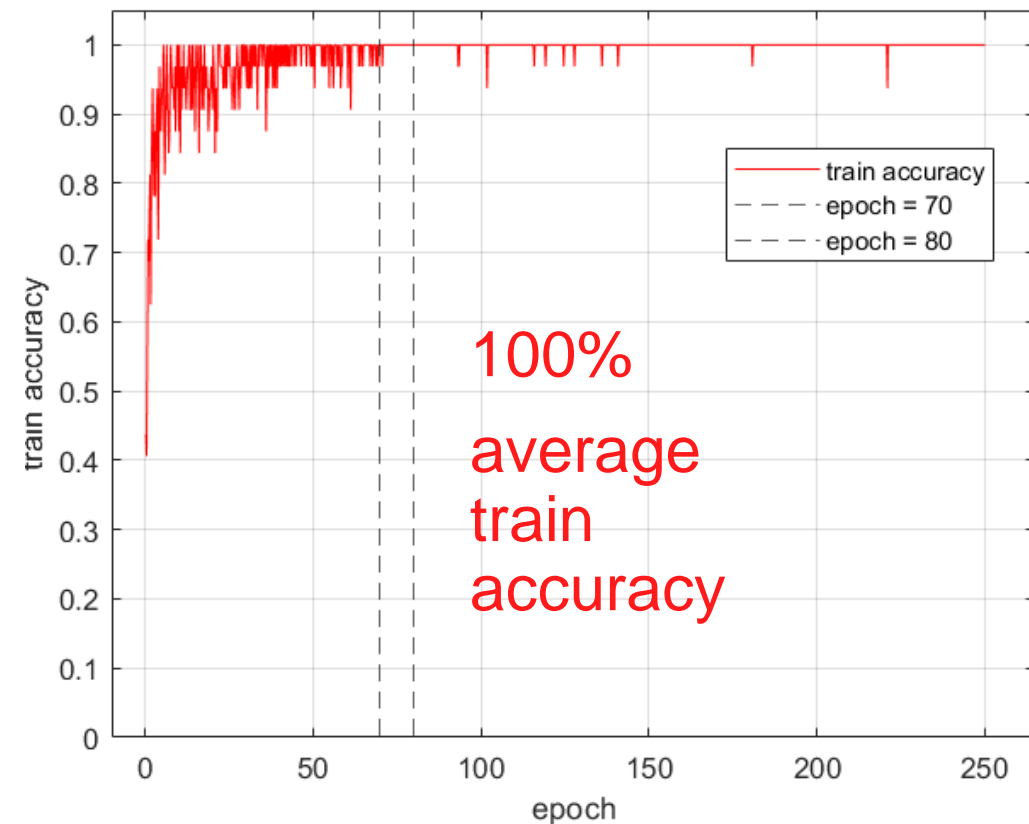
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max = 96.88%

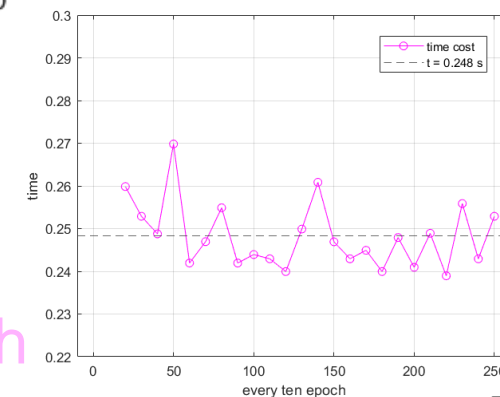
overfit



NVIDIA Quadro P5000 ;
16GB ;
2560 CUDA Kernel

converge at epoch 70~80

0.248 s / 10 epoch



Results and Analysis



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1. Extend dataset

less in category and quantity, **distinct** feature

cap

plat

vertical

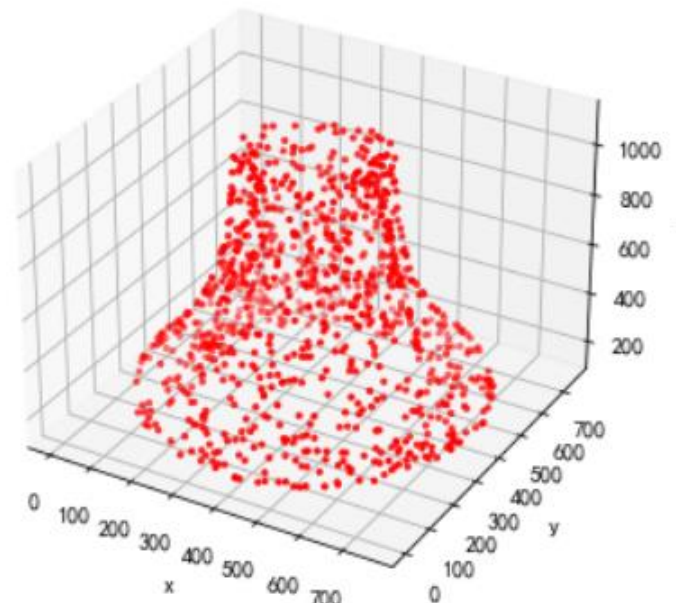
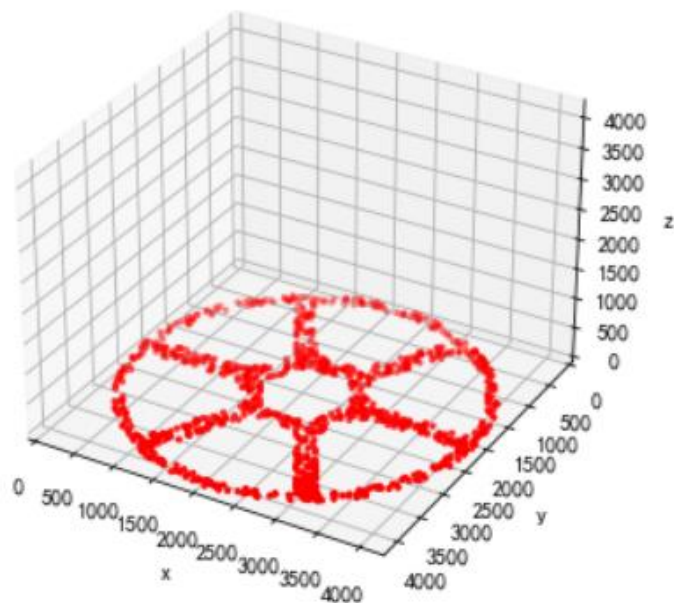
$[-7.1288e+00, -1.3477e-03, -7.5145e+00]$

cap

plat

vertical

$[-1.6996e-01, -2.4479e+00, -2.6618e+00]$



Results and Analysis



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1. Extend dataset

less in category and quantity, **distinct** feature

cap

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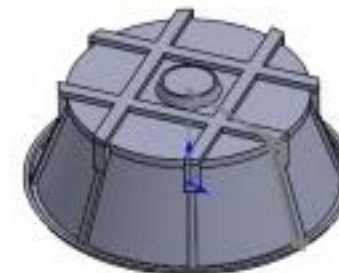
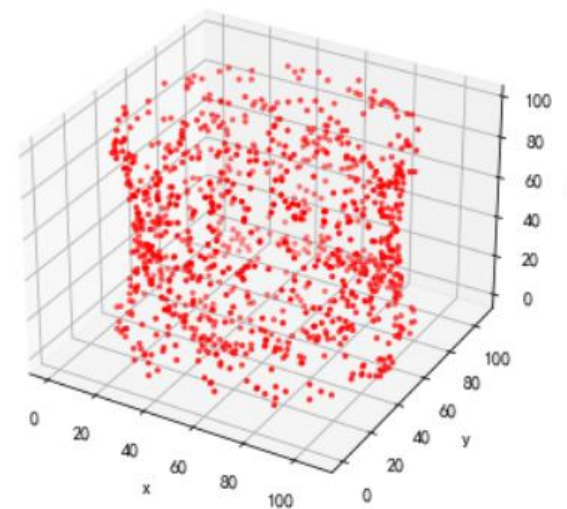
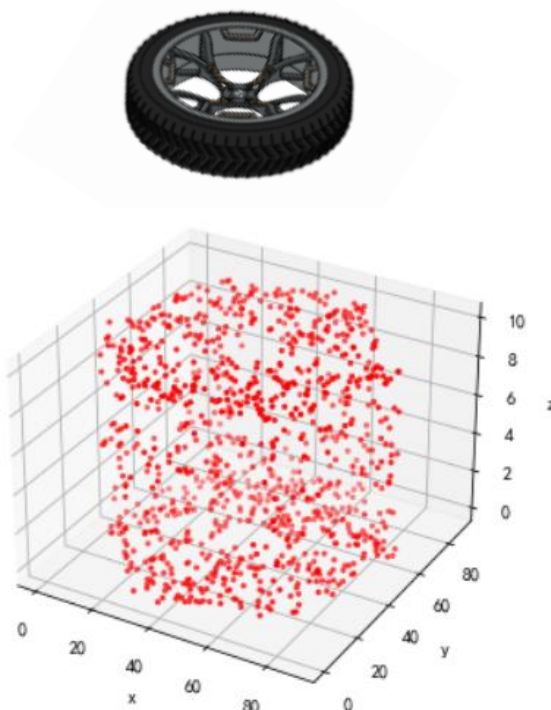
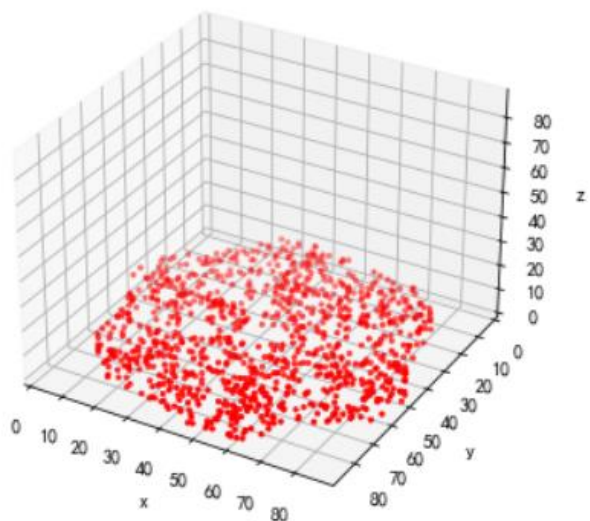
$[-4.4001e+00, -3.3846e+00, -4.7268e-02]$

cap

plat

vertical

$[-7.2082e+00, -7.6716e+00, -1.2071e-03]$



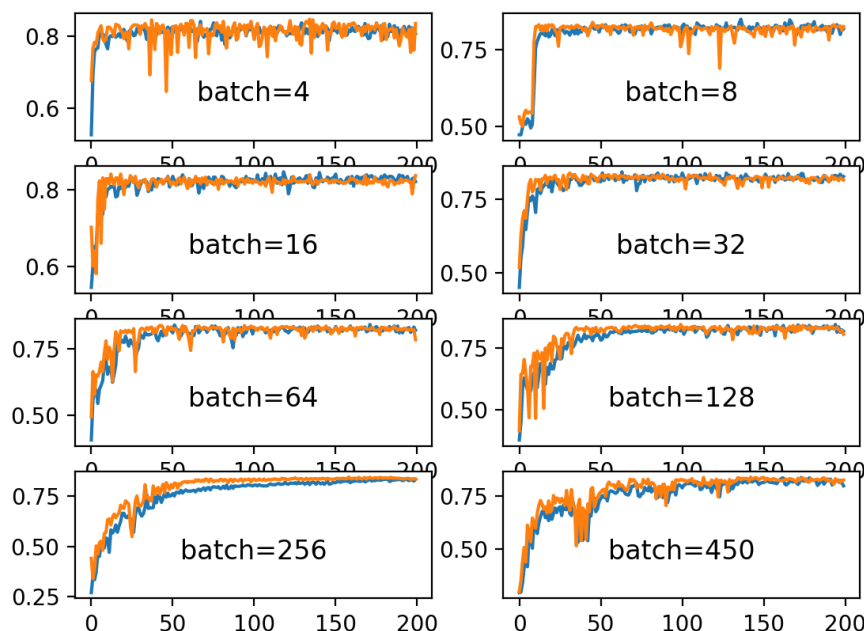
Results and Analysis



2. Optimize network

Increase dataloader(num_workers)

Adjust dataloader(batch_size)



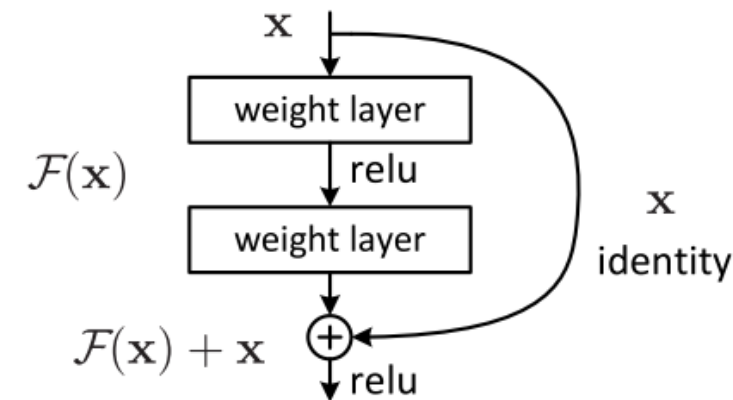
Advantage

- Representable
- Less concussion
- More precise
- Smooth and stable
- Less iteration

Disadvantage

- Limited RAM
- Global learning rate
- Fixed direction
- More time cost

3. Upgrade networks



Innovation



1. classification on **3D models** with point cloud vectors
2. a **pathway** from STL models to processing technics
3. **PointNet** nested with **ResNet**

Q & A



THANK YOU!