Deep Learning on 3D Point Clouds

Deep Learning in Remote Sensing

Episode-4

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Capturing a 3D World

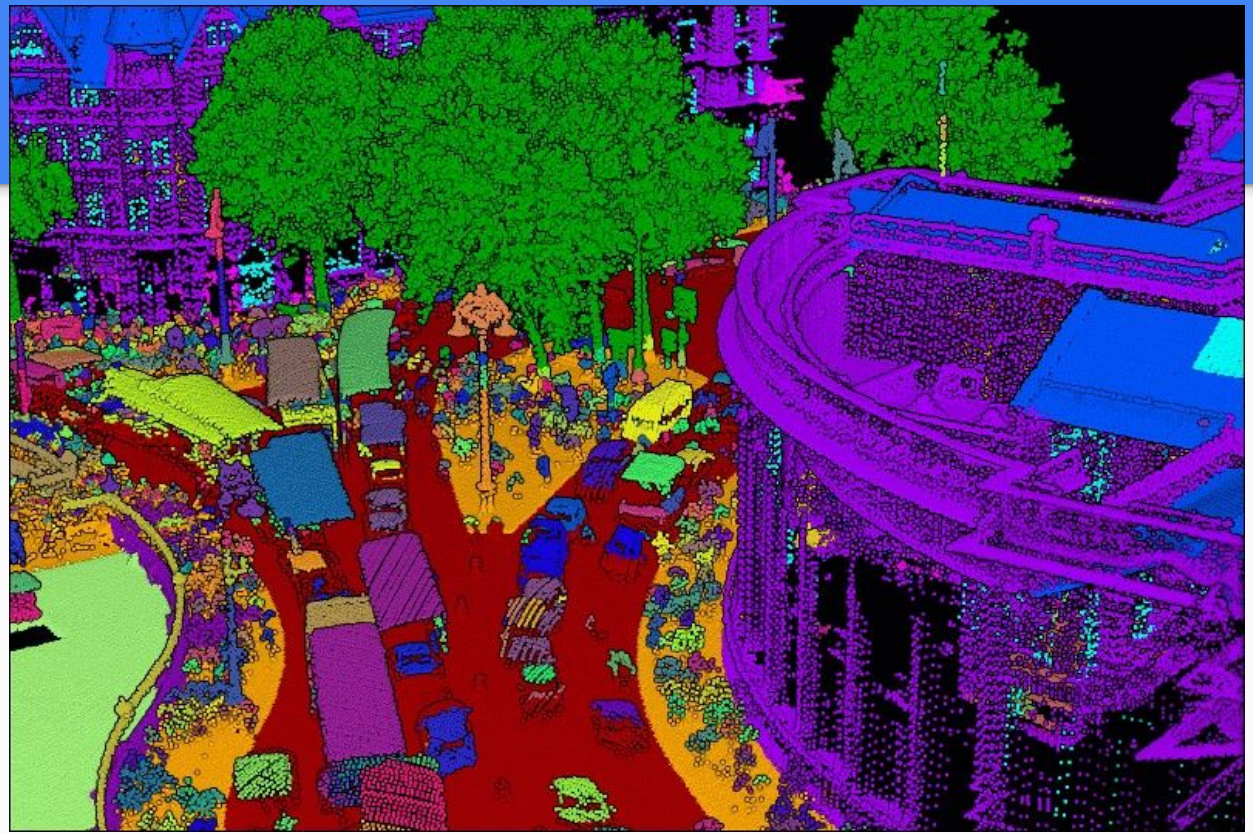
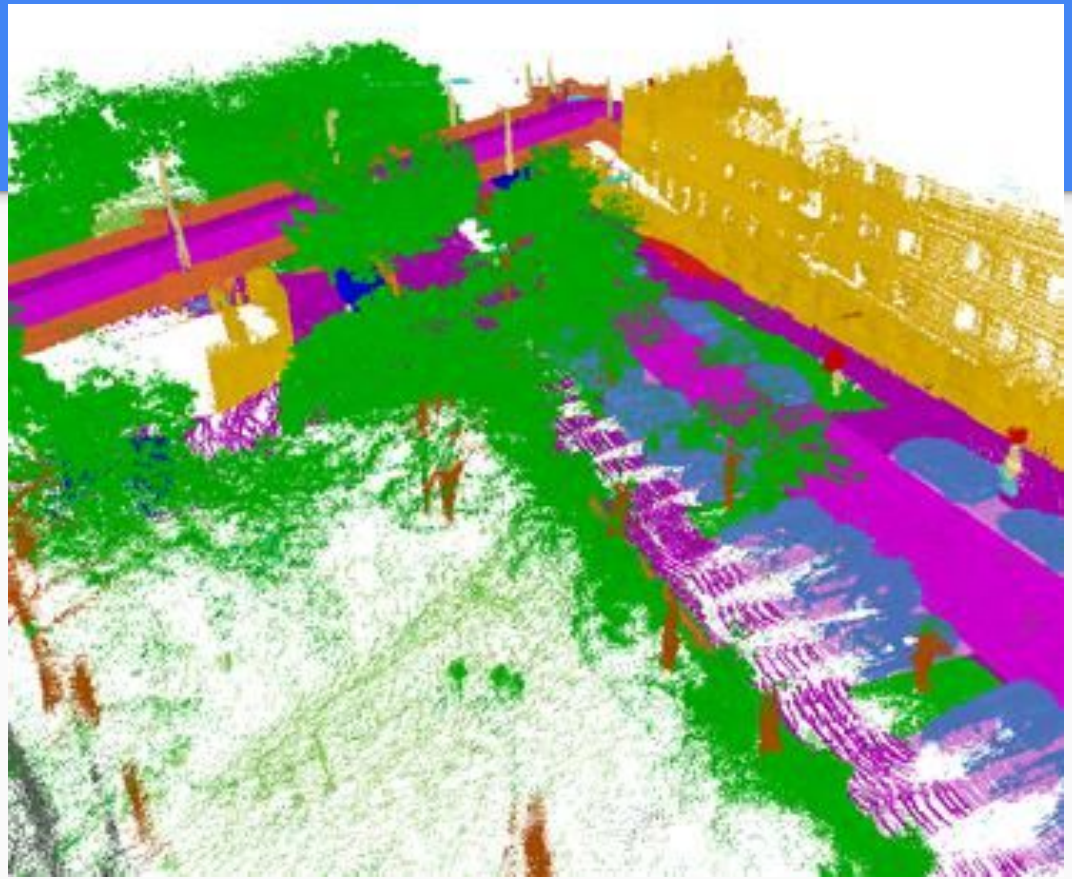


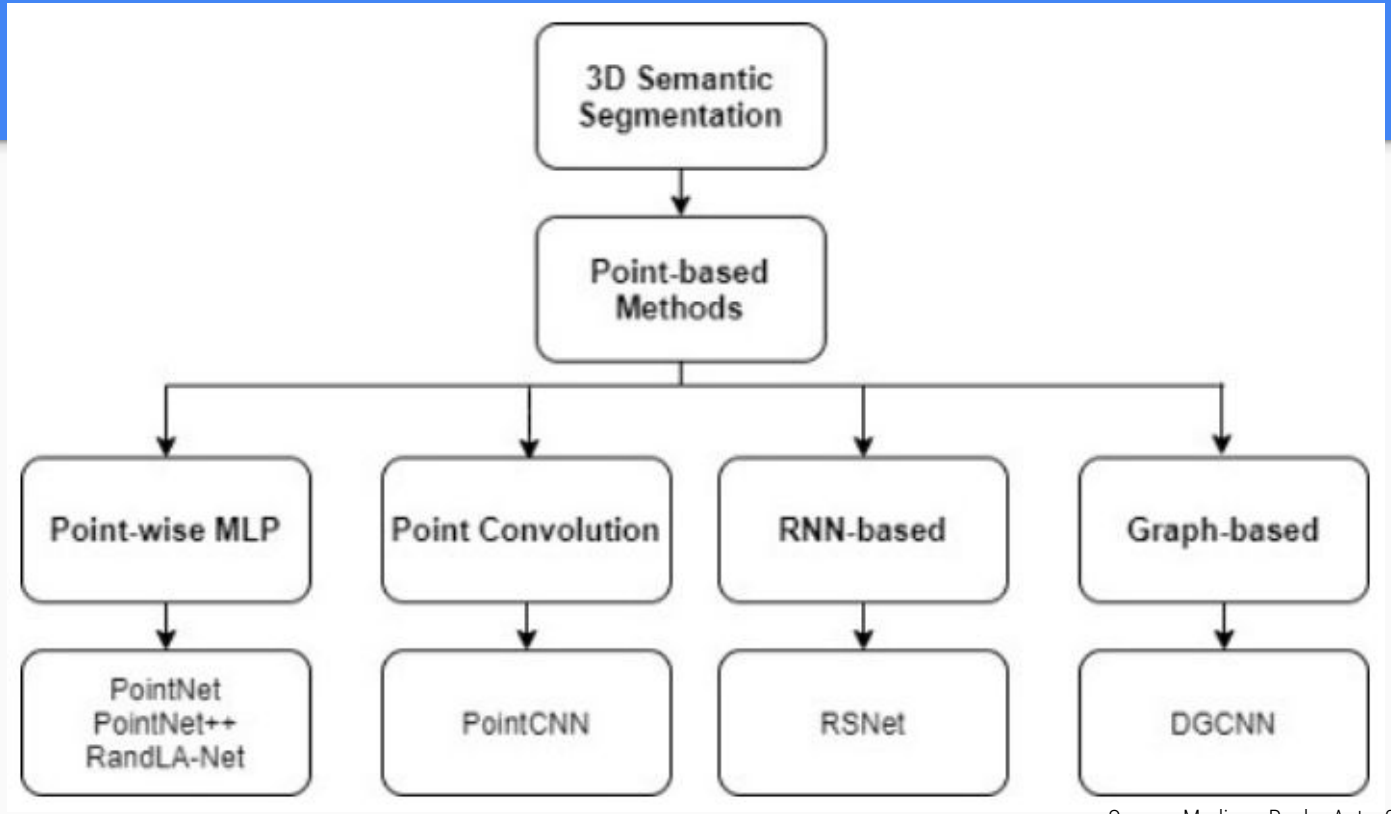
Image source: Florent Poux, Medium, Towards Data Source

Capturing a 3D World

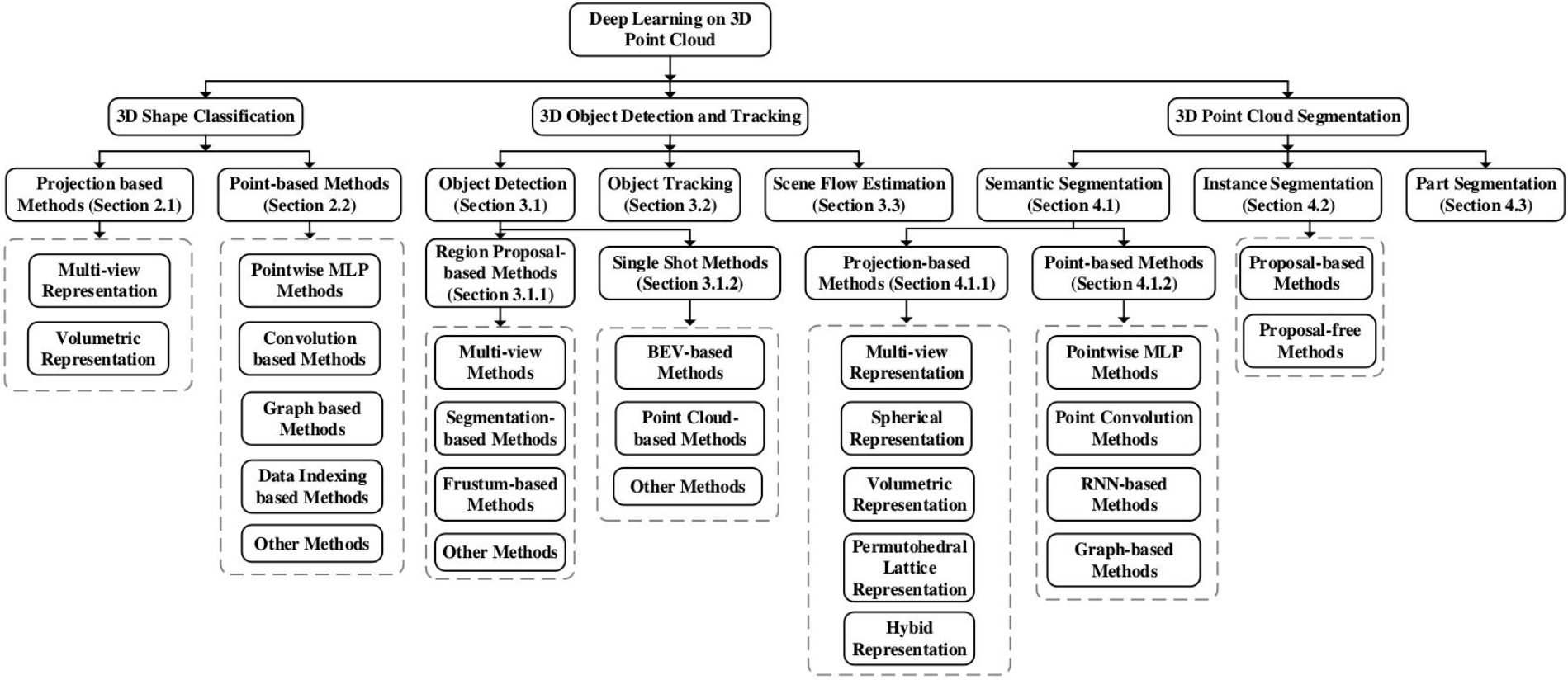


Paperswithcode, 3D Semantic Segmentation

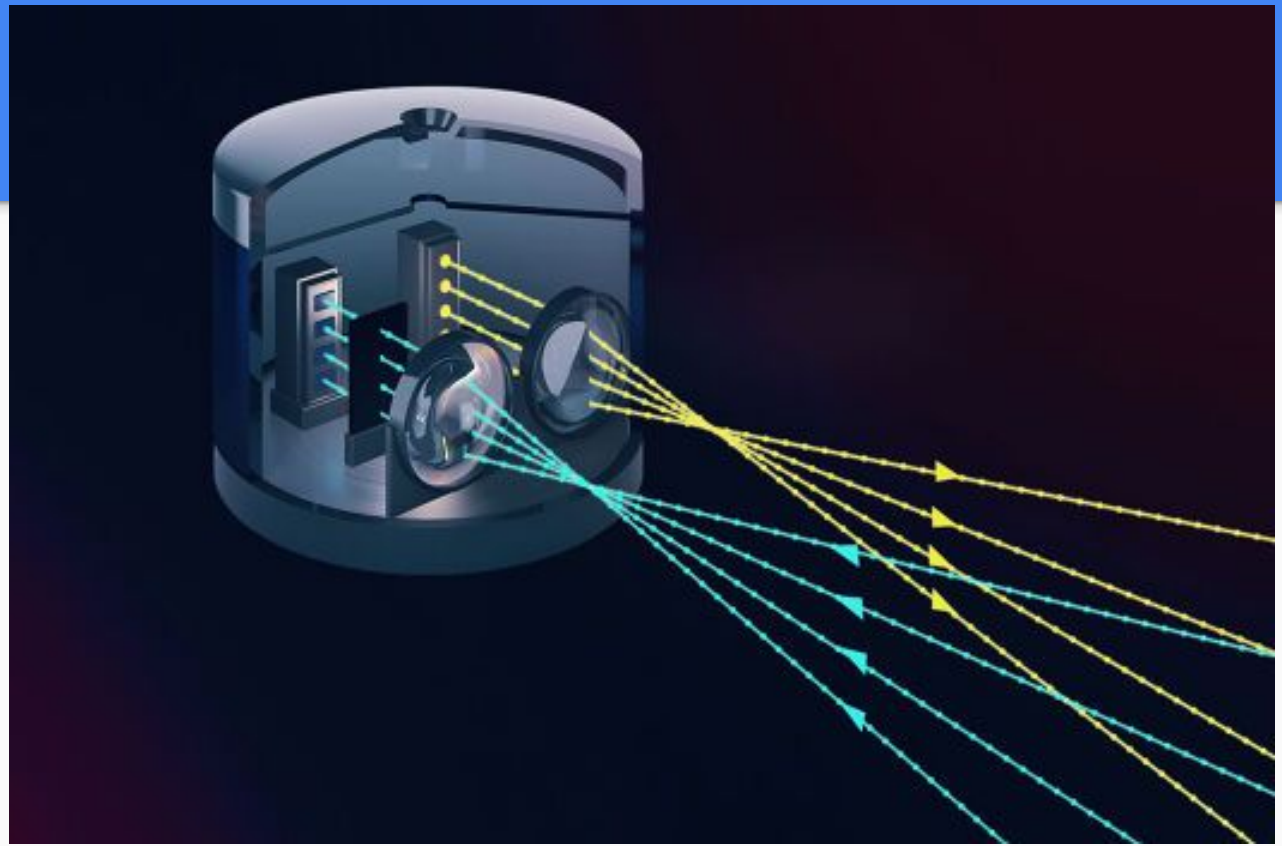
3D Problems and Deep Learning Techniques



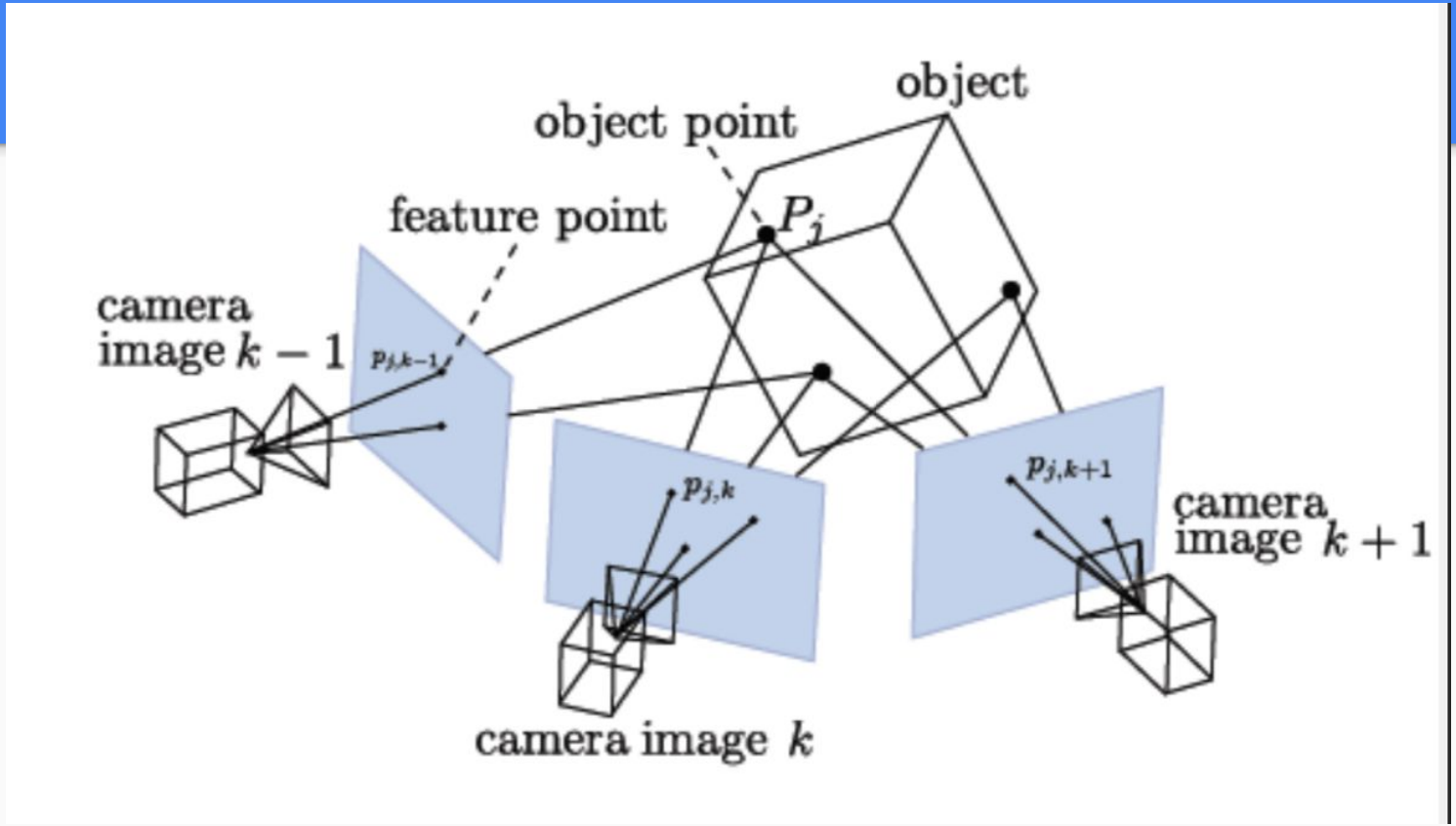
Source: Medium, Rucha Apte, 3D Point Cloud Semantic Segmentation Using Deep Learning Techniques



LiDAR



3D Cloud Point

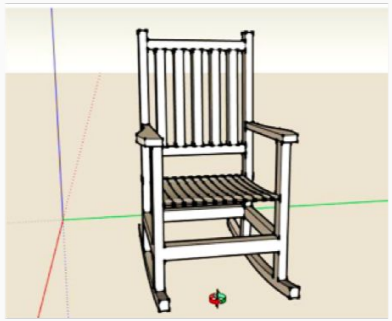


2D image

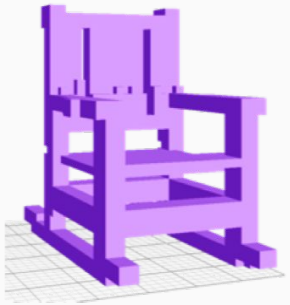
1	44	33	12	20	23	35	14
51	16	40	32	46	48	28	17
29	60	3	63	49	55	36	7
52	22	26	41	38	10	61	53
2	24	19	11	34	43	5	8
57	9	37	42	25	21	27	18
30	56	50	64	4	59	6	13
58	47	45	31	39	15	62	54

Pixel

3D model



Polygonal mesh



Voxel (volumetric pixel)

Point cloud

Image source: Medium, Create 3D Model from a Single 2D image in Pytorch, Phúc Lê

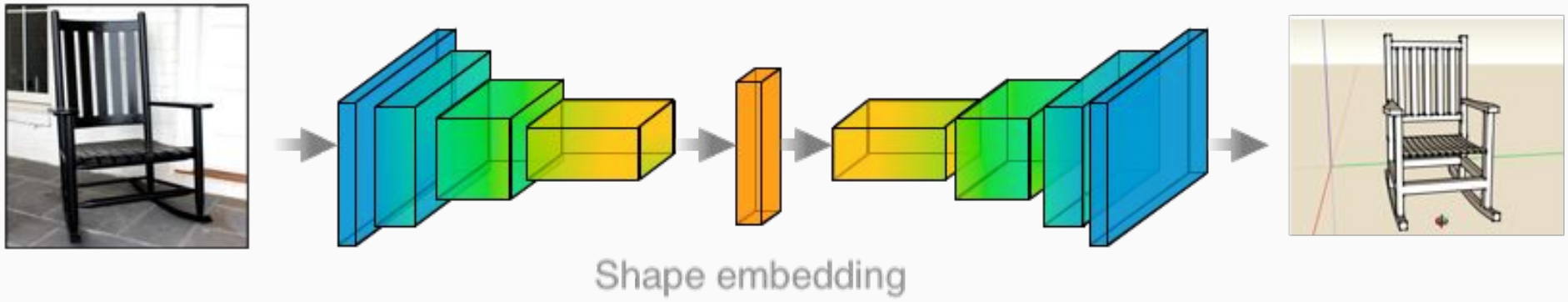
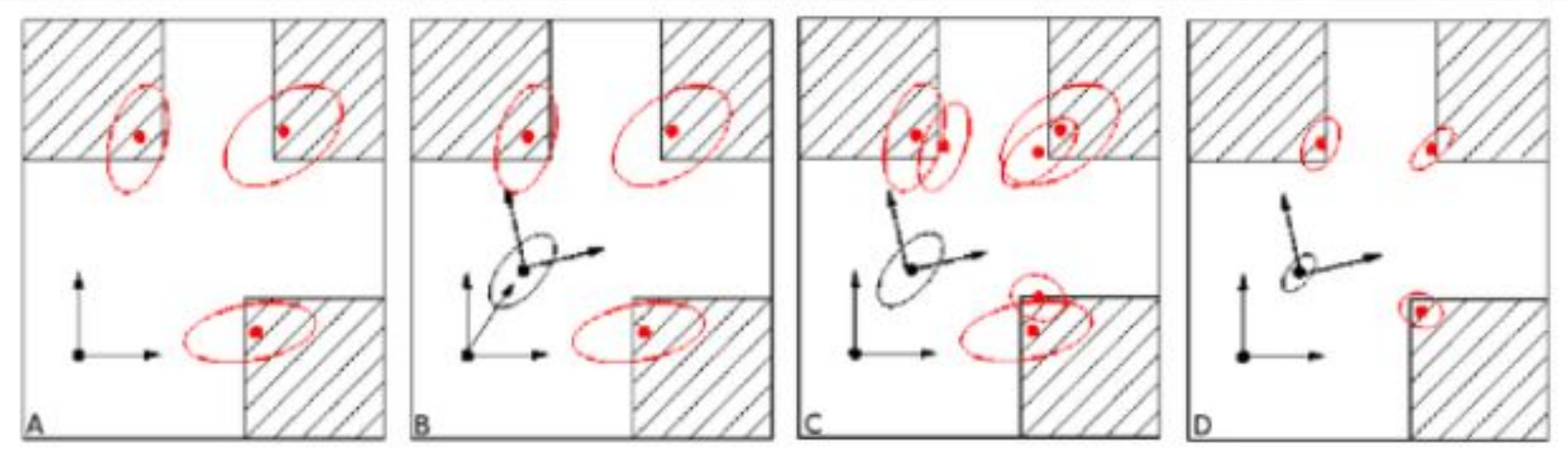


Image source: Medium, Create 3D Model from a Single 2D image in Pytorch, Phúc Lê

Can be computed from images: stereo, SfM, SLAM

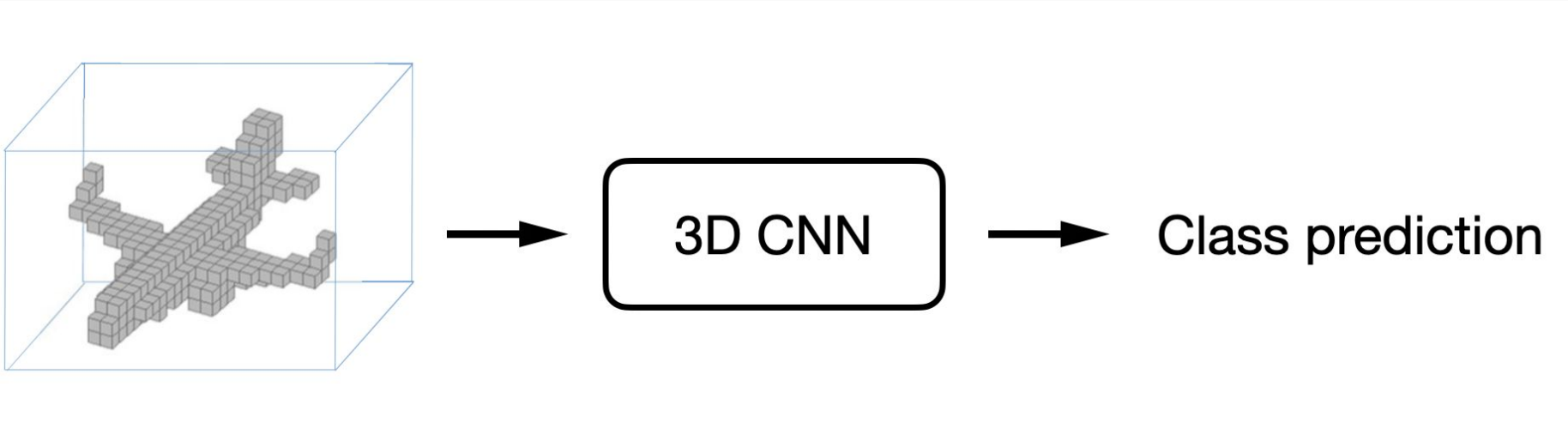
Simultaneous localization and mapping(SLAM)



Medium, Sadık Kaplan

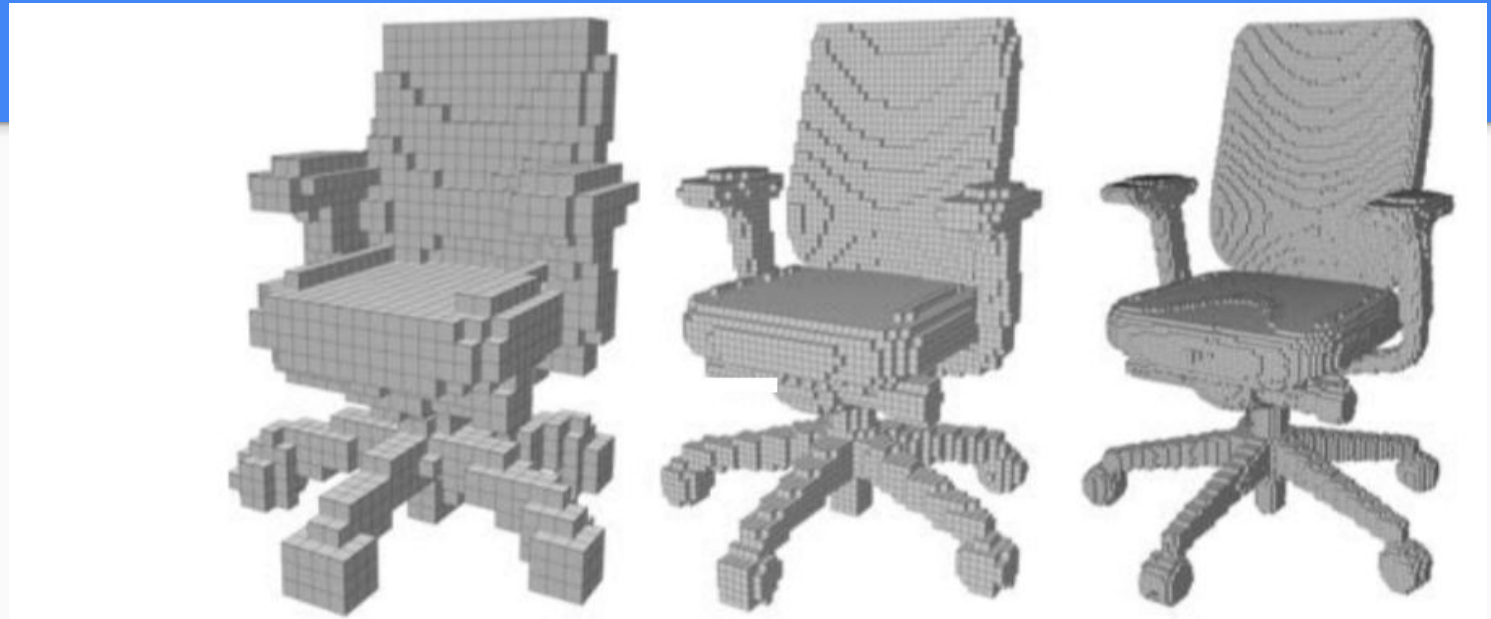
Deep Learning on 3D Point

Idea and generalization: 2D is important for 3D

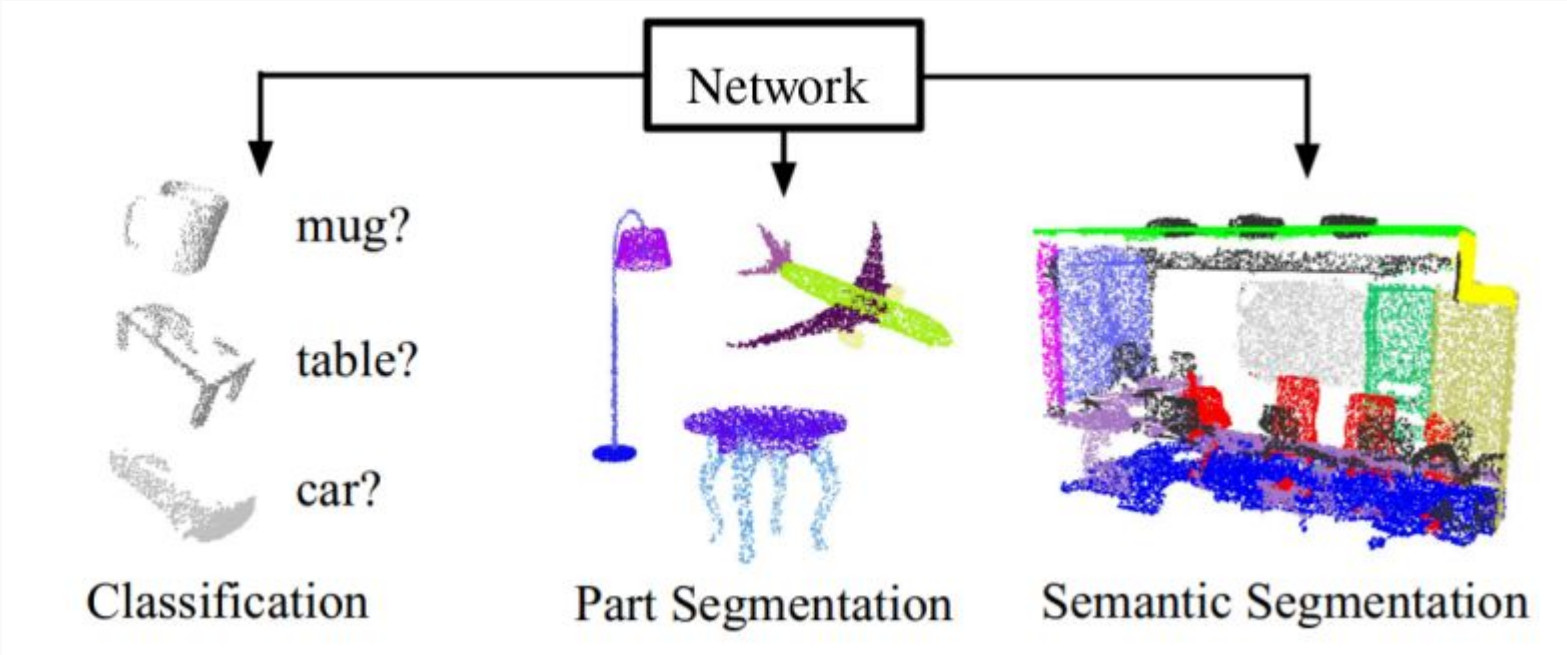


Source: arXiv:1604.03265v2 [cs.CV] 29 Apr 2016

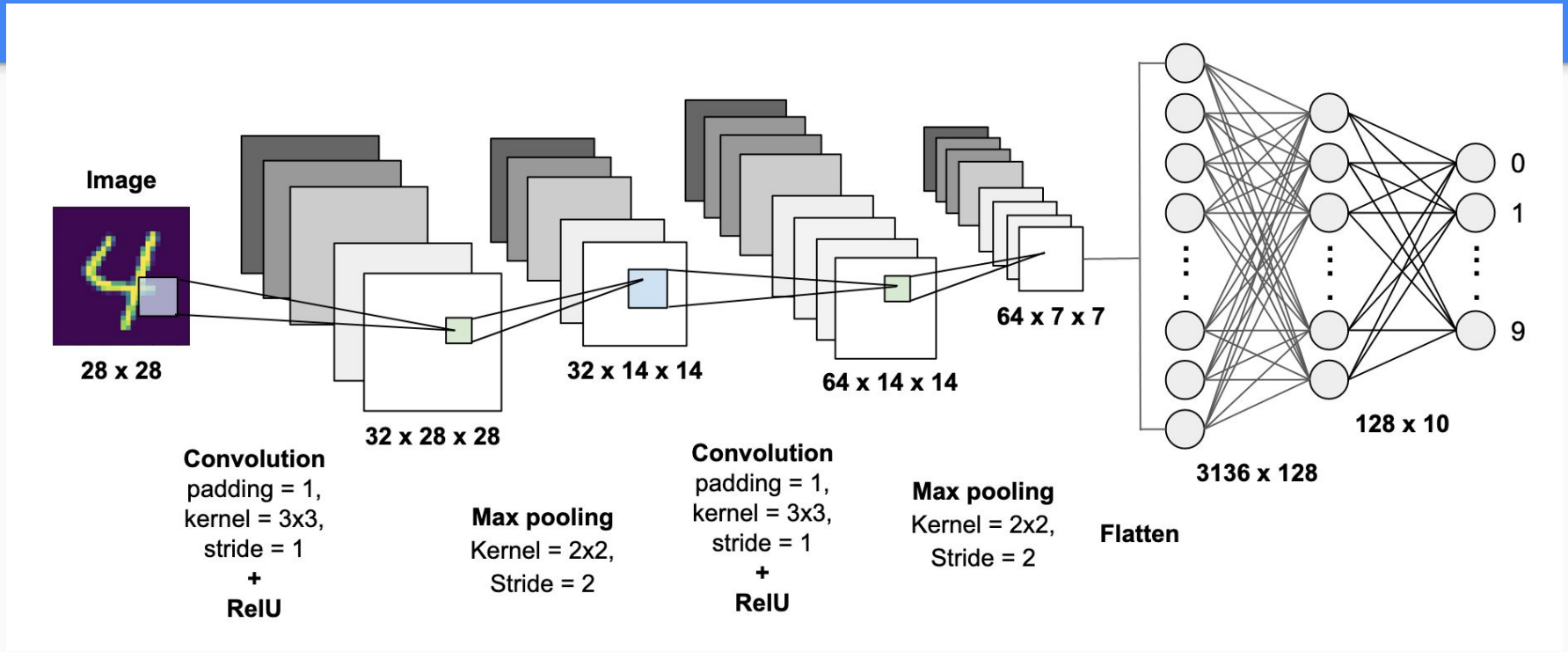
Voxel, Density and Resolution



Classification



Example CNN



Source: Medium, becominghuman.ai , Shreyak

CNN and 3D

```
# point cloud1 and point cloud2 represent the same 3D structur
# even though they are represented differently in memor
```

```
point cloud1 = [(x1, y1, z1), (x2, y2, z2),..., (xn, yn, zn)]
point_cloud2 = [(x2, y2, z2), (x1, y1, z1),..., (xn, yn, zn)]
```

2D projection == 3D coordinates (x,y,z) + binary mask (m)

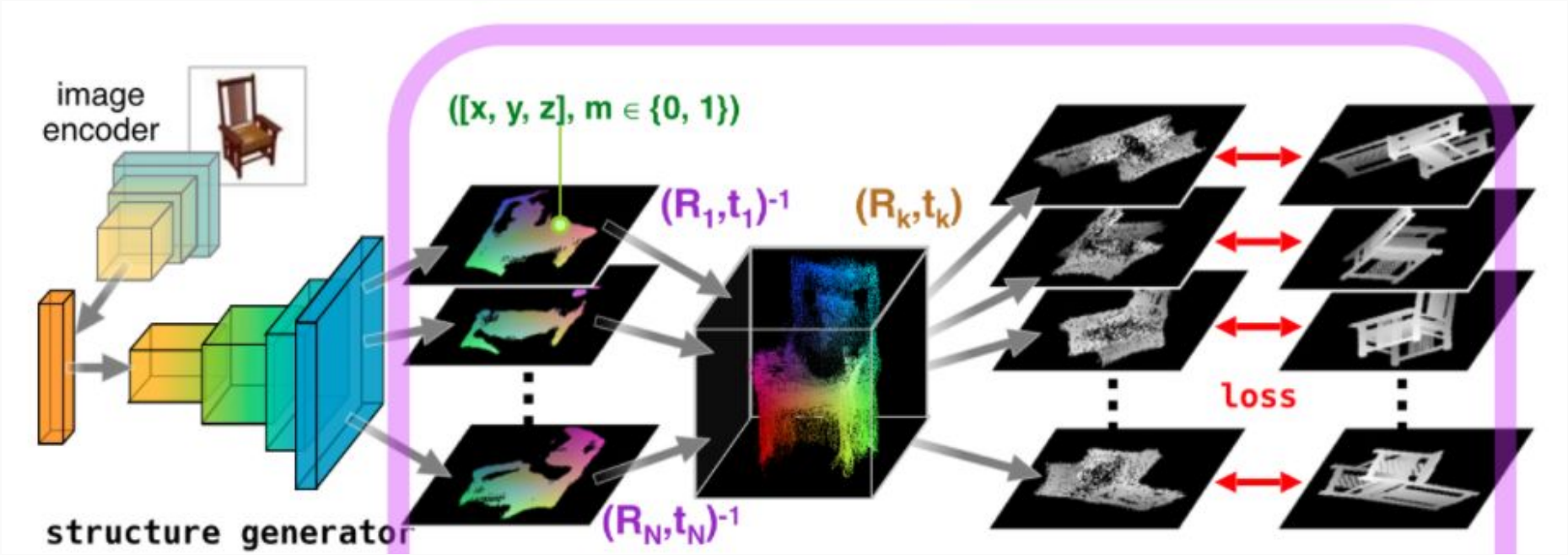
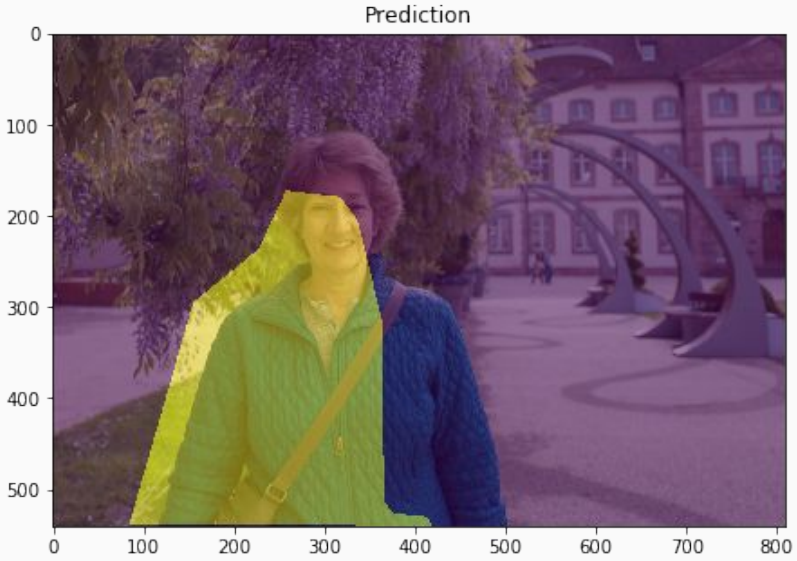
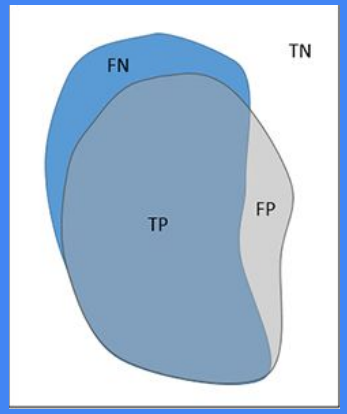


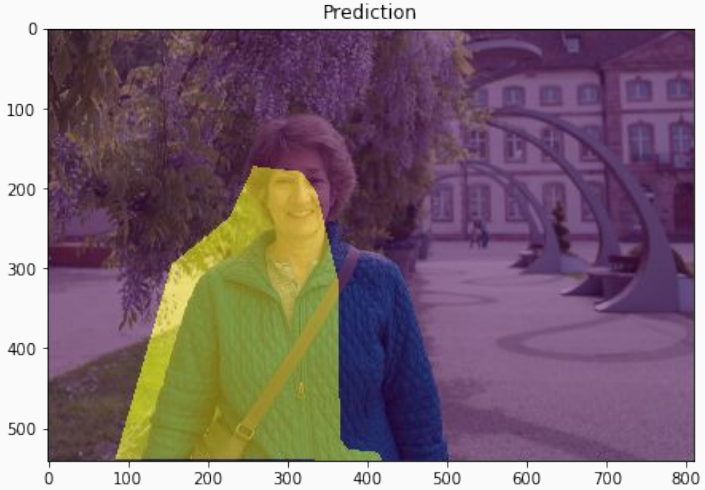
Image source: Medium, Create 3D Model from a Single 2D image in Pytorch, Phúc Lê

Performance Measures





	Actual = Yes	Actual = No
Predicted = Yes	TP	FP
Predicted = No	FN	TN



Some Performance Measures

$$PA = \frac{TP}{N}$$

$$MPA = \frac{\sum_{i=1}^{k} \frac{TP_i}{FP_i + TP_i}}{k}$$

$$IoU_i = \frac{TP_i}{FP_i + FN_i + TP_i}$$

Public Datasets

3D Shape Classification

- ModelNet (CVPR'15)
  - ModelNet10
  - ModelNet40
- PartNet (CVPR'19)
- ScanObjectNN

3D Object Detection

- KITTI (CVPR'12)
  - *3D objecct detection*
  - *BEV*
- ApolloScape (TPAMI'19)
- Argoverse (CVPR'19)
- A*3D (arXiv'19)
- Waymo (arXiv'19)

Source: Github, QingyongHu, SoTA-Point-Cloud

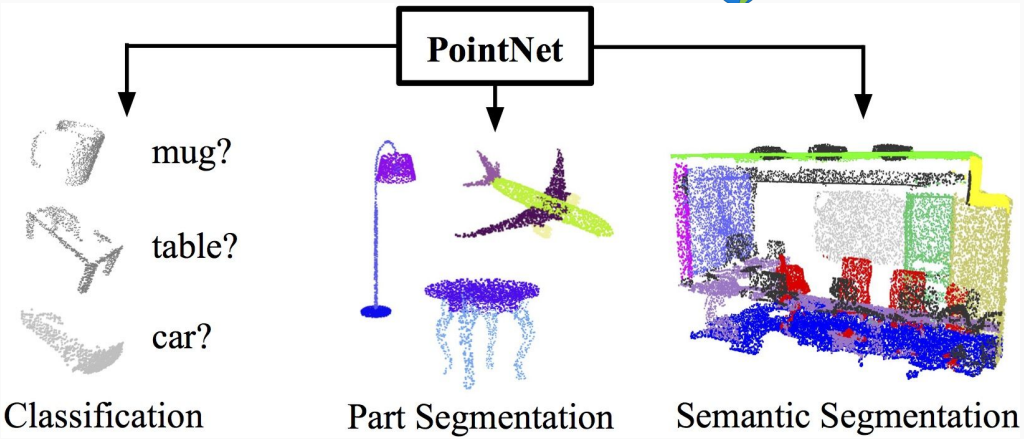
Public Datasets

3D Point Cloud Segmentation

- Semantic3D (ISPRS'17)
  - *semantic-8*
  - *reduced-8*
- S3DIS (CVPR'17)
- ScanNet (CVPR'17)
- NPM3D (IJRR'18)
- DublinCity (BMVC'19)
- SemanticKITTI (ICCV'19)
- nuScenes (CVPR'20)
- Toronto-3D (CVPRW'20)
- DALES (CVPRW'20)
- Campus3D (ACM MM'20)
- SensatUrban (CVPR'21)

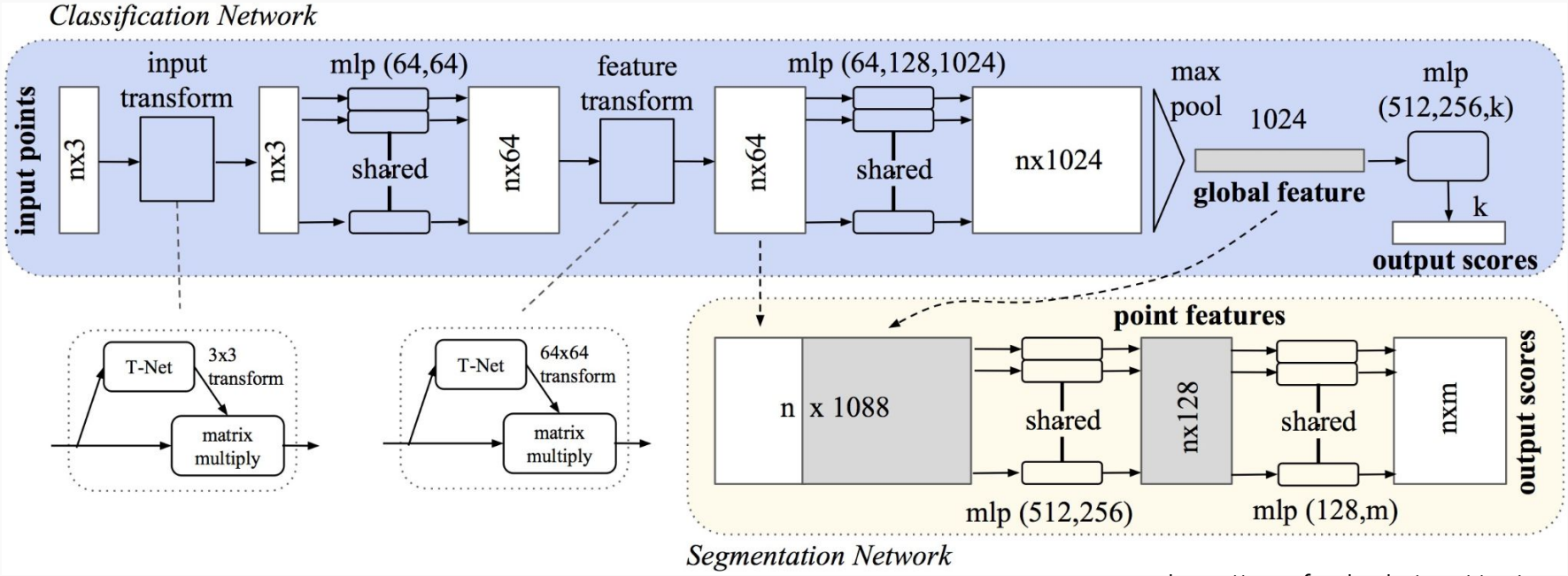
Source: Github, QingyongHu, SoTA-Point-Cloud

Effective Neural Network for Point Cloud



- PointNet
- PointNet++
- RandLA-Net
- PointCNN

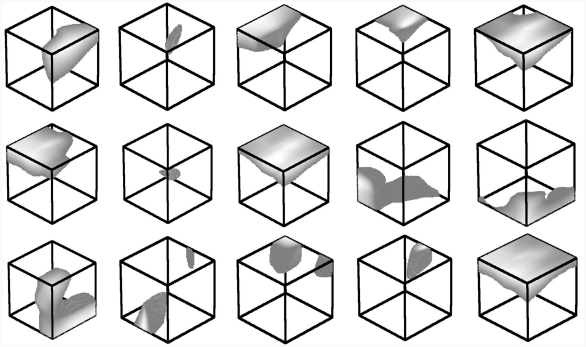
PointNet

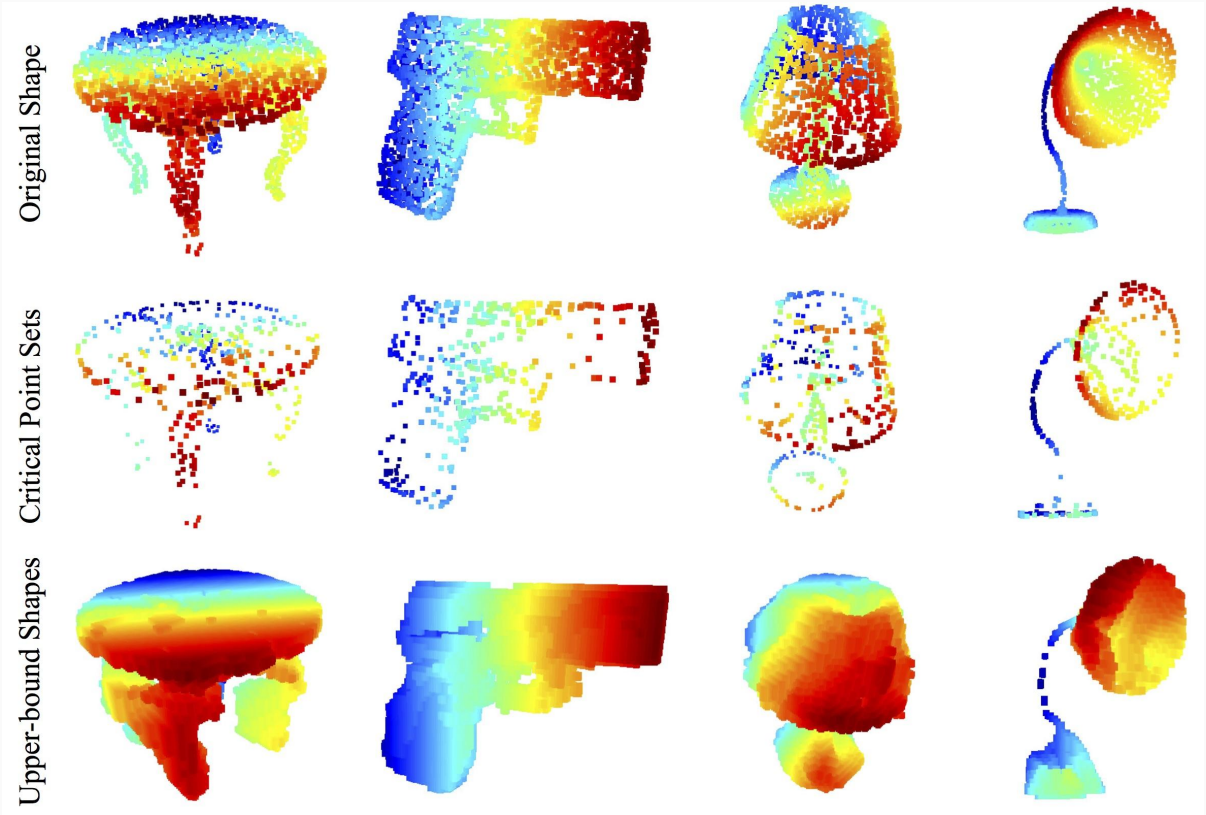


http://stanford.edu/~rqi/pointnet/

Semantic Segmentation

http://stanford.edu/~rqi/pointnet/





http://stanford.edu/~rqi/pointnet/

Video

If you want to watch the presentation please visit the video

https://www.youtube.com/watch?v=Fr11bsdCAvg&t=16s&ab_channel=UHUZAMCSCRS

THANKS

Does anyone have any questions?

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