AI Ukraine - 2017

Point cloud labeling using machine learning

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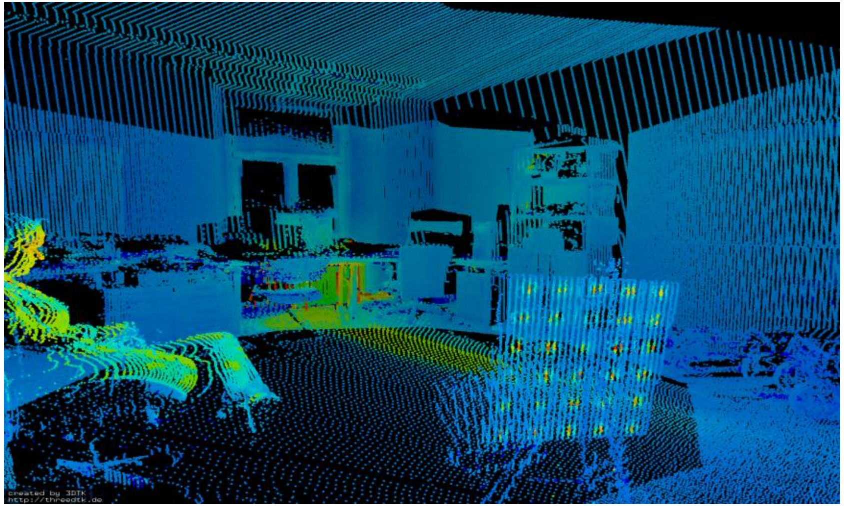
Data sources

1. LIDAR
2. 3D IR cameras
3. Generated from 2D sources



3D dataset: http://kos.informatik.uni-osnabrueck.de/3Dscans/
by Dorit Borrmann from Jacobs University Bremen gGmbH, Germany.

Data sources

3D sensors not so expensive now.

Quality. Speed. Weight. Range. Angle

Velodine LeddarTech Riegl Routescene YellowScan Leica Geosystems Scanse

3D cameras and 3D Scanners

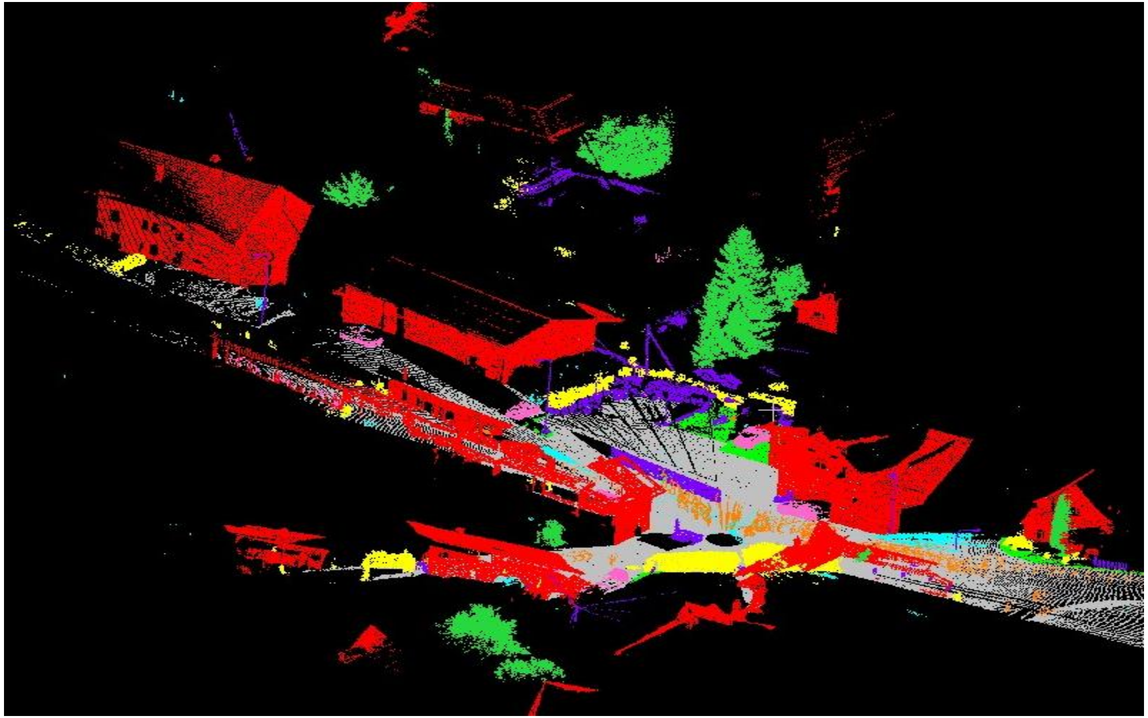
Point Cloud Datasets

http://www.semantic3d.net/
https://sites.google.com/site/kevinlai726/datasets
http://www.cvlibs.net/datasets/kitti/raw_data.php
https://sourceforge.net/projects/pointclouds/files/PCD%20datasets/

…

and more

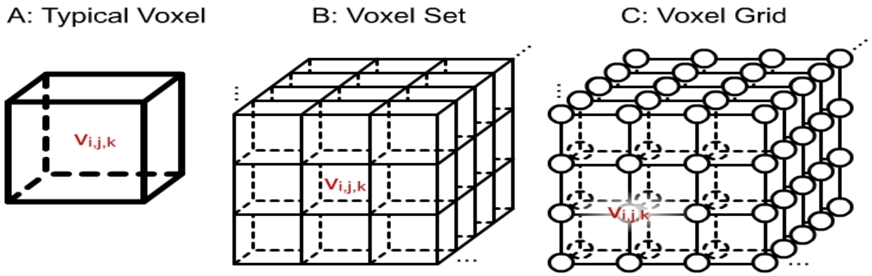
Labeling



http://www.semantic3d.net/view_dbase.php?chl=1

Pre-processing

Dense Voxel Grid:



Read more and image from: http://johnrichie.com/V2/richie/isosurface/volume.html

Huang J., You S. Point cloud labeling using 3d convolutional neural network
Pattern Recognition (ICPR), 2016 23rd International Conference on.– C. 2670-2675.

Pre-procesing

Problem with Voxel Grid (Volumetric CNN):

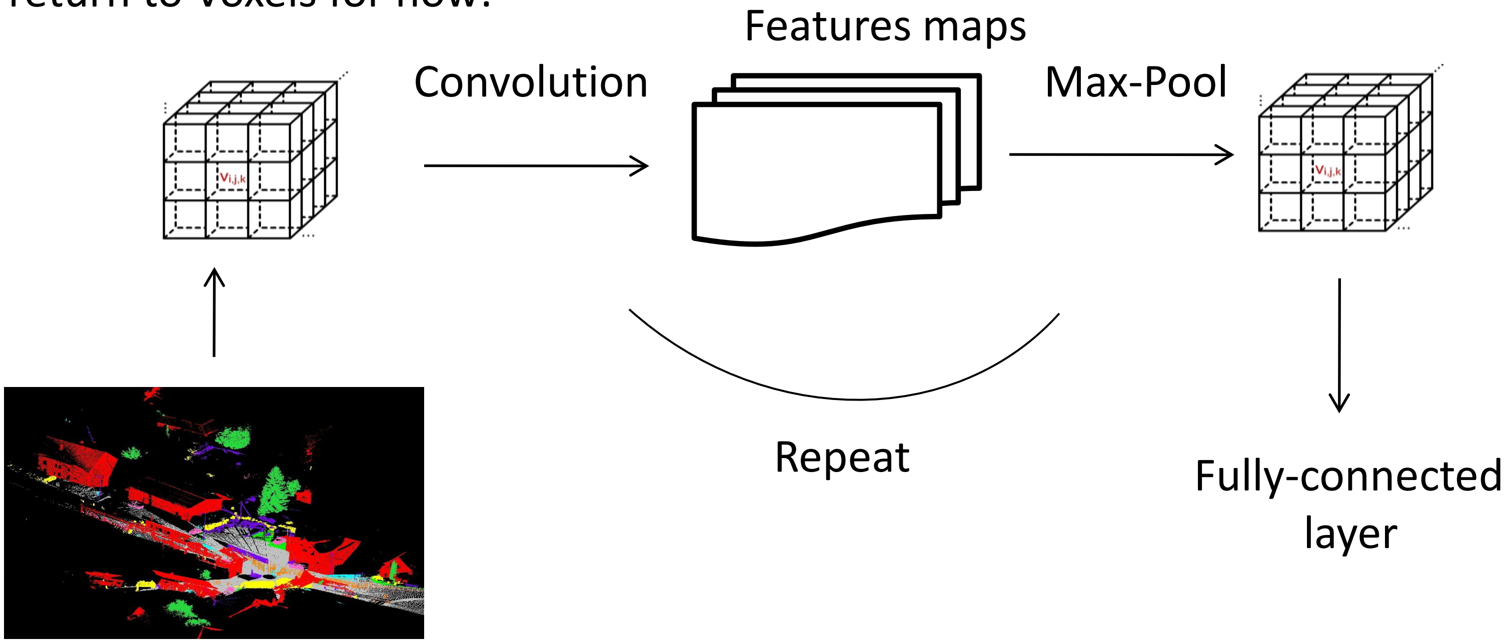
1. Sparsity
2. Size (Memory usage raise up!)
3. Density approximation

Solutions:

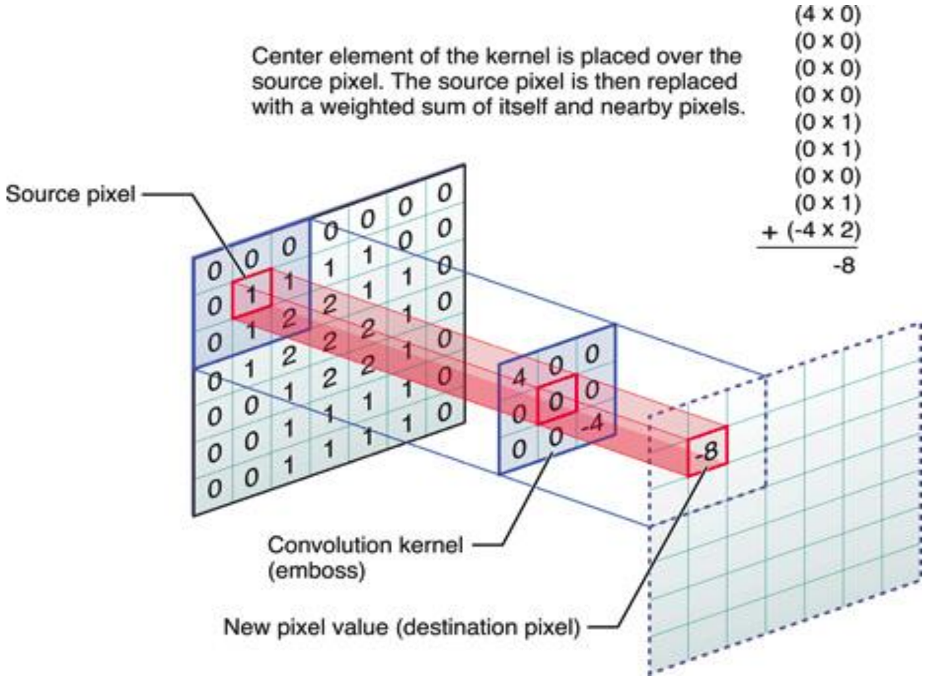
1. FPNN
2. Spectral CNN
3. Multiview CNN
4. Spectral CNN
5. Feature-based DNN
6. Deep Learning on **Unordered Sets**

Labeling pipeline

But, return to Voxels for now:

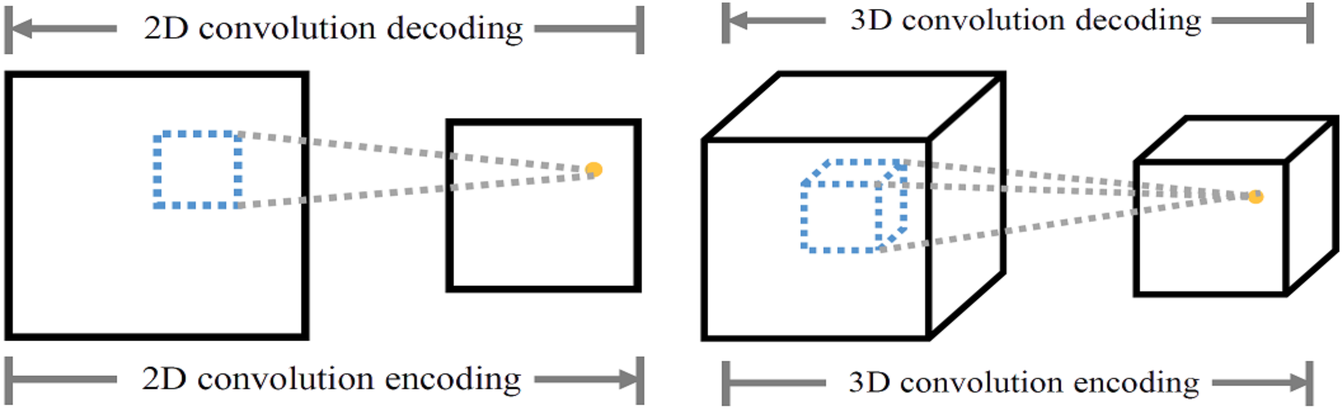


Why convolution?



https://hcordeirodotcom.files.wordpress.com/2012/02/atividade-2-kernel-convolution.jpg

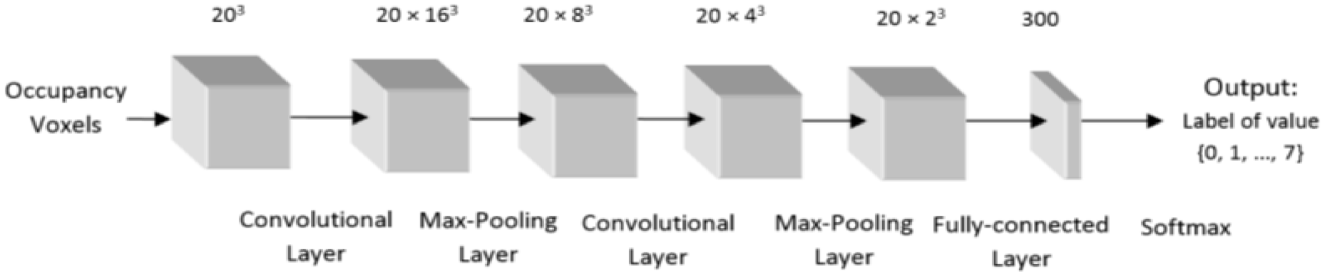
Convolution in 3D



https://www.autodeskresearch.com/blog/kdd-2016-autodesk-research

$$v_{lm}^{xyz} = b_{lm} + \sum_{q} \sum_{i=0}^{f-1} \sum_{j=0}^{f-1} \sum_{k=0}^{f-1} w_{lmq}^{ijk} v_{(l-1)q}^{(x+i)(y+j)(z+k)}$$

3D convolution neural network



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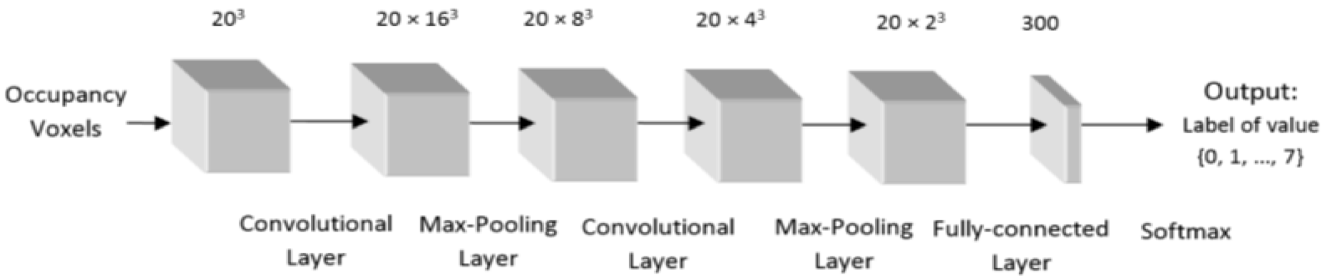
Let's remember - this is classical **CNN** , why not DNN?

3D convolution neural network



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Let's remember - this is classical **CNN** , why not DNN?

Sparsity! Memory size!

Pre-processing

What if we do not want to use Dense Voxel Grid?

There are 3 ways to deal with unordered sets :

1) Sort input into a canonical order;

2) Treat the input as a sequence to train an RNN, but augment the training data by all kinds of permutations;

3) Use a simple symmetric function to aggregate the information from each point. Symmetric function takes n vectors as input and outputs a new vector that is invariant to the input order.

Readings:

1. A. Garcia-Garcia, F. Gomez-Donoso†, J. Garcia-Rodriguez, S. Orts-Escolano, M. Cazorla, J. Azorin-Lopez. PointNet: A 3D Convolutional Neural Network for Real-Time Object Class Recognition
2. Ayan Sinha, Jing Bai, Karthik Ramani. Deep Learning 3D Shape Surfaces Using Geometry Images ECCV 2016
3. Xu Xu and Sinisa Todorovic. Beam Search for Learning a Deep Convolutional Neural Network of 3D Shapes
4. A Lightweight 3D Convolutional Neural Network for Real-Time 3D Object Recognition
5. Roman Klokov, Victor Lempitsky Escape from Cells: Deep Kd-Networks for The Recognition of 3D Point Cloud Models
6. Charles R. Qi, Hao Su, Kaichun Mo, and Leonidas J. Guibas. PointNet: Deep Learning on Point Sets for 3D Classification and Segmentation. CVPR 2017.
7. Yangyan Li, Soeren Pirk, Hao Su, Charles R. Qi, and Leonidas J. Guibas. FPNN: Field Probing Neural Networks for 3D Data. NIPS 2016.
8. Charles R. Qi, Hao Su, Matthias Niessner, Angela Dai, Mengyuan Yan, and Leonidas J. Guibas. Volumetric and Multi-View CNNs for Object Classification on 3D Data. CVPR 2016.
9. K. Sfikas, T. Theoharis and I. Pratikakis. Exploiting the PANORAMA Representation for Convolutional Neural Network Classification and Retrieval. 3DOR2017.
10. Martin Simonovsky, Nikos Komodakis Dynamic Edge-Conditioned Filters in Convolutional Neural Networks on Graphs.
11. Chu Wang, Marcello Pelillo, Kaleem Siddiqi1 Dominant Set Clustering and Pooling for Multi-View 3D Object Recognition..