



Group of
Horribly
Optimistic
Statisticians



CV SEMINAR

3D COMPUTER VISION: INTRO

30.04.2024 Computer Vision Seminar 23/24



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Agenda

1. Wizja komputerowa w 2D a 3D
2. Reprezentacje danych 3D
3. Typy segmentacji
4. Segmentacja z użyciem DL





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[\[3D Machine Learning\] - 3D data representations — Antoine Toisoul](#)



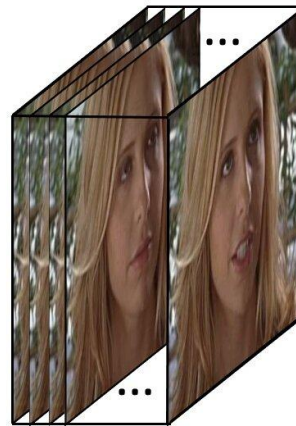
Tensory



Vector : 1D array



Image : 2D tensor
(for each color channel)



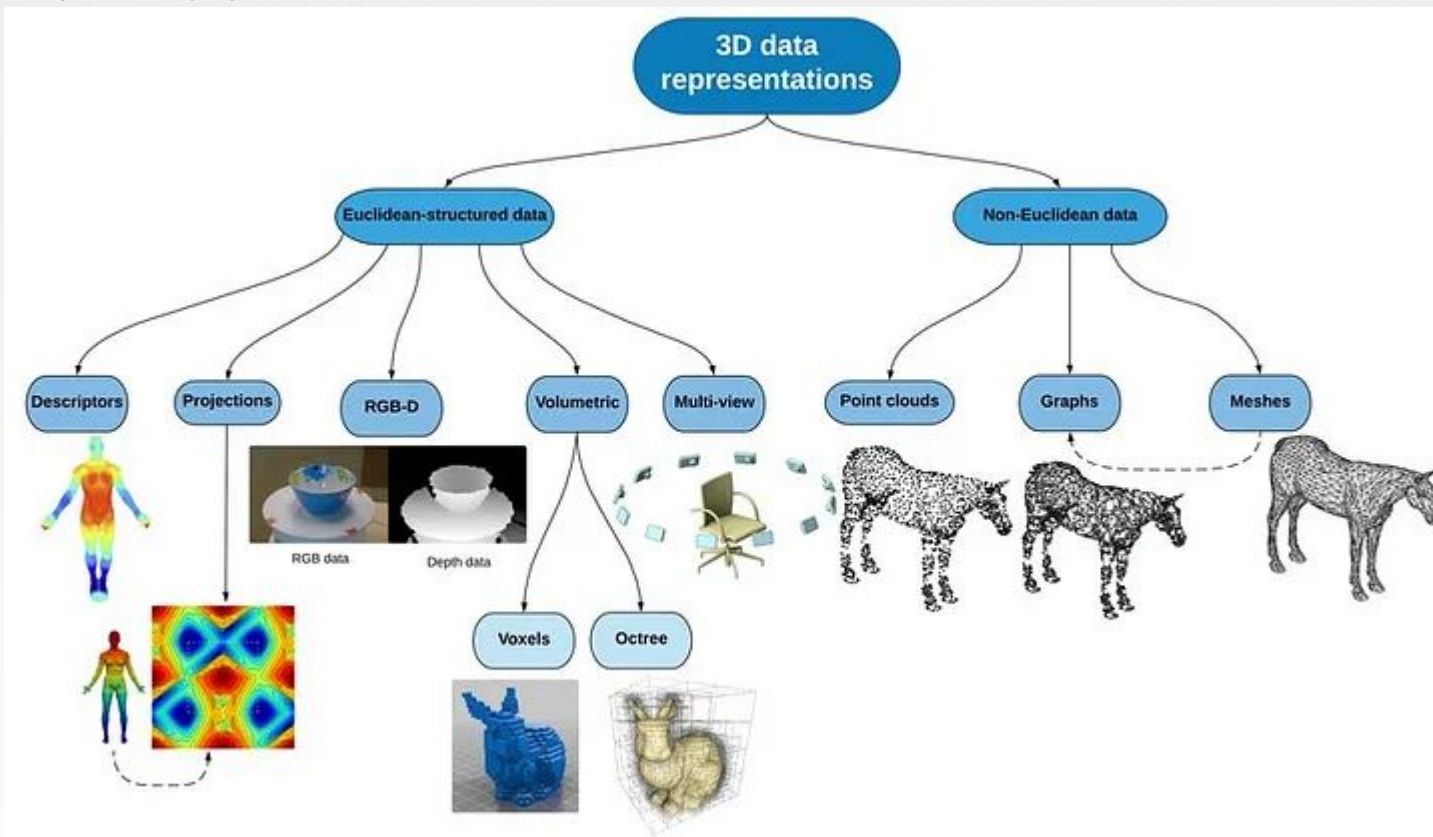
Video : 3D tensor
(for each color channel)



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[From Pixels to 3D Shapes: An Overview of 3D Data Representations | by Dedeepya Lekkala | Medium](#)

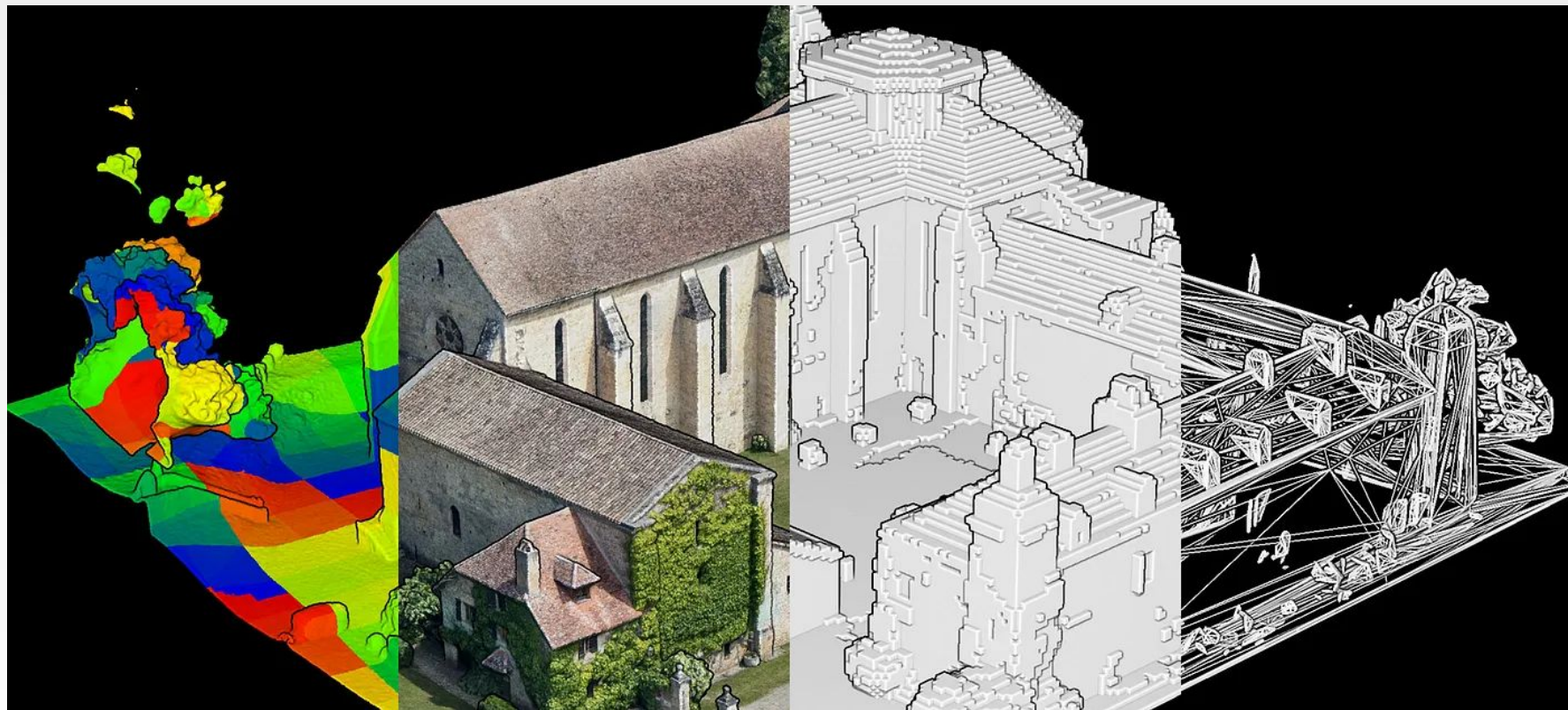




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[How to represent 3D Data](#)



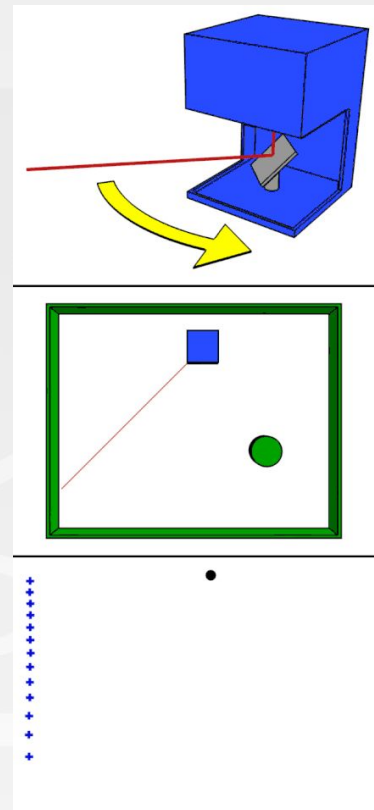
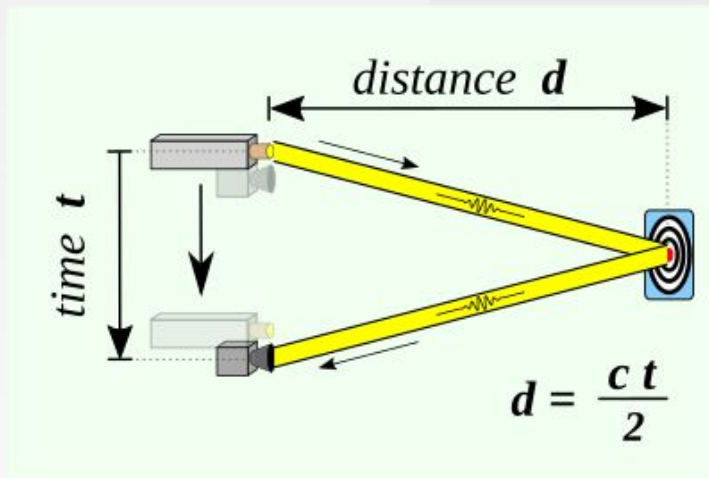
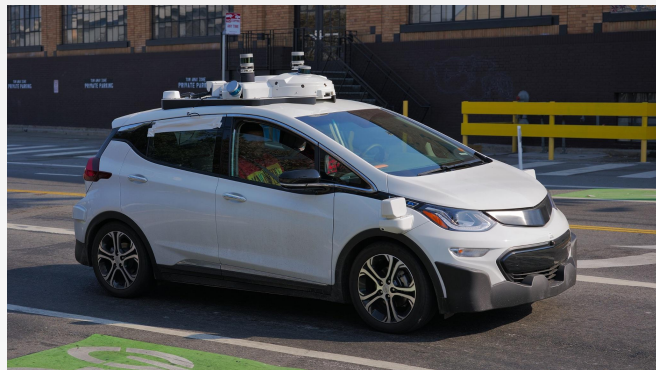


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LiDAR – light detection and ranging



[Lidar - Wikipedia](#)



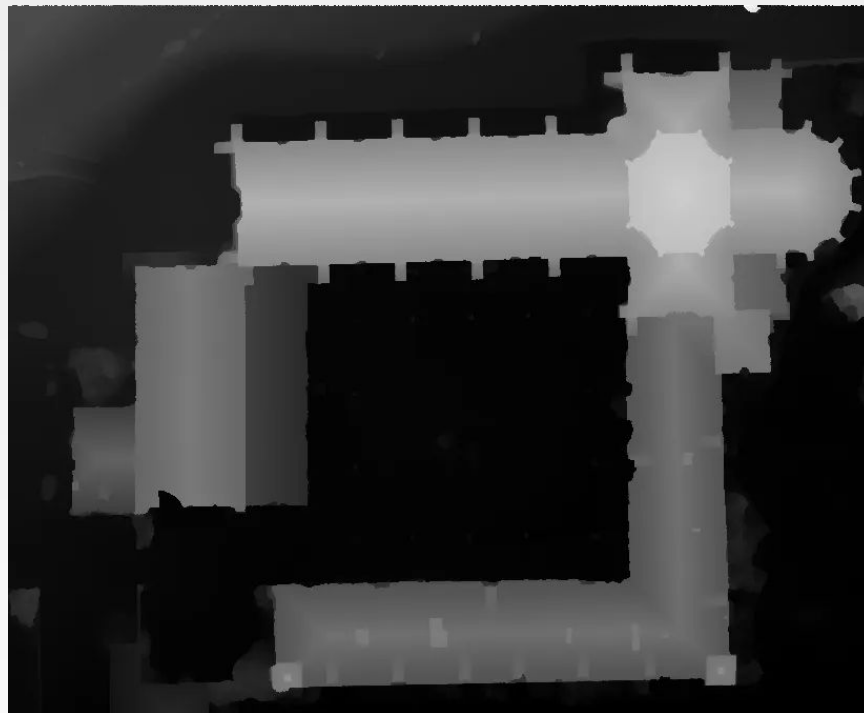
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Depth map

- Zdjęcie/kanal
- Jasność pikseli oznacza głębieć (im jaśniej, tym bliżej znajduje się obiekt)



[How to represent 3D Data](#)



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RGB-D

- Połączenie informacji o kolorze (RGB) z głębią (D)
- Informacja 2,5D
- Prosta, popularna reprezentacja



[How to represent 3D Data](#)



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[How to represent 3D Data](#)



Projekcje

- Istnieje bardzo dużo projekcji tego samego obiektu
- Sferyczne/birds-eye
- Strata informacji w wyniku projekcji





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Multi-view

- Sposób na szum, niepełną informację, okluzję (occlusion)
- Trudne pytanie: ile potrzeba takich ujęć?



[How to represent 3D Data](#)



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Woksele (voxels, volumetric picture element)

- Odpowiednik piksela w 3D
- Przedstawienie sceny jako trójwymiarowej tablicy
- Przechowują informację o tym, co jest w środku bryły (solid modelling)

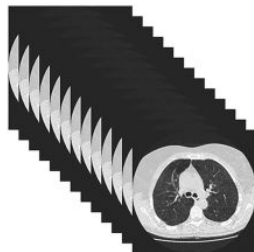
Chest Radiograph



5mm Chest CT Scan



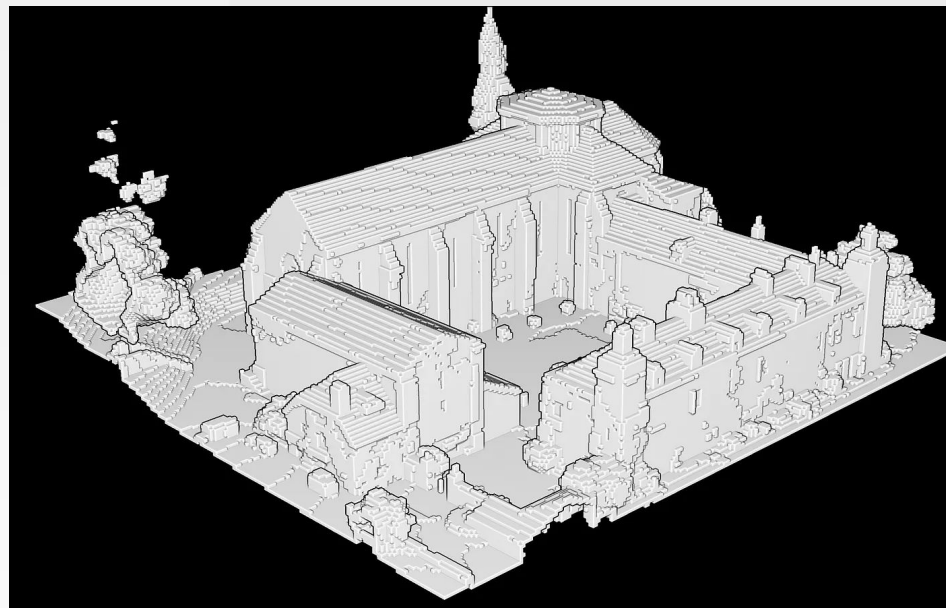
1mm Chest CT Scan



$2520 \times 3032 =$
 $7,640,640$ pixels
5mm nodule $\sim 3.67 \times 10^{-5} \%$

$512 \times 512 \times 69 =$
 $18,087,936$ voxels
5mm nodule (1 slice) $\sim 1.55 \times 10^{-5} \%$

$512 \times 512 \times 492 =$
 $128,974,848$ voxels
5mm nodule (5 slices) $\sim 1.09 \times 10^{-5} \%$





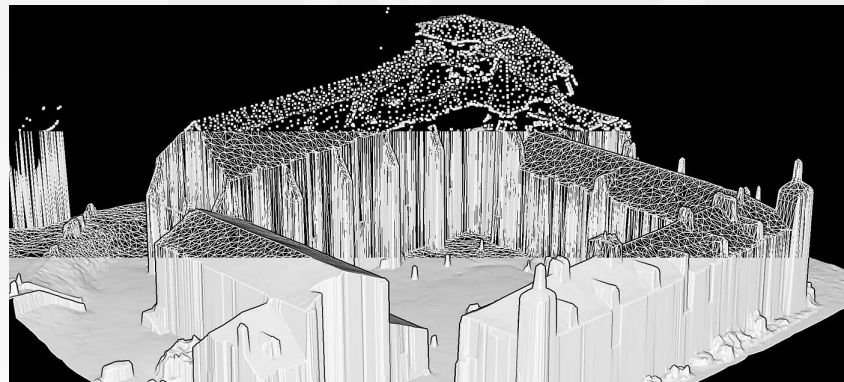
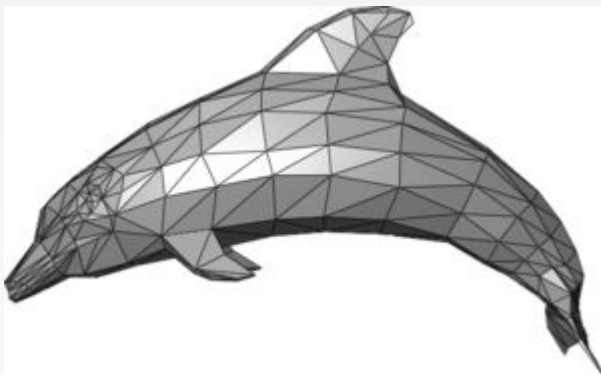
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Siatka (mesh)

- Wykorzystuje wielokąty połączone ze sobą krawędziami
- Zwykle proste wielokąty, np. trójkąty





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Chmury punktów

- Zbiór punktów w układzie trójwymiarowym
- Współrzędne X, Y, Z
- Dane zebrane np. przez LiDAR
- Szybkie renderowanie
- Brak struktury (trudne do przetworzenia przez CNN)





Equivalence of Representations



- Thesis:
 - Each fundamental representation has enough expressive power to model the shape of any geometric object
 - It is possible to perform all geometric operations with any fundamental representation!
- Analogous to Turing-Equivalence:
 - All computers today are turing-equivalent, but we still have many different processors

Computational Differences



- Efficiency
 - Combinatorial complexity (e.g. $O(n \log n)$)
 - Space/time trade-offs (e.g. z-buffer)
 - Numerical accuracy/stability (degree of polynomial)
- Simplicity
 - Ease of acquisition
 - Hardware acceleration
 - Software creation and maintenance
- Usability
 - Designer interface vs. computational engine



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Typy segmentacji



[Image Segmentation: Deep Learning vs Traditional \[Guide\]](#)

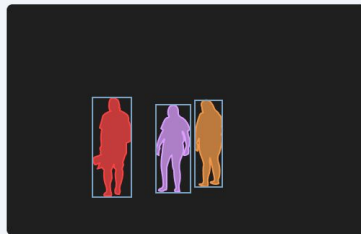
Semantic Segmentation vs. Instance Segmentation vs. Panoptic Segmentation



(a) Image



(b) Semantic Segmentation



(c) Instance Segmentation



(d) Panoptic Segmentation

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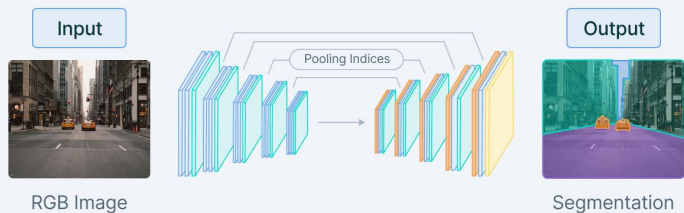


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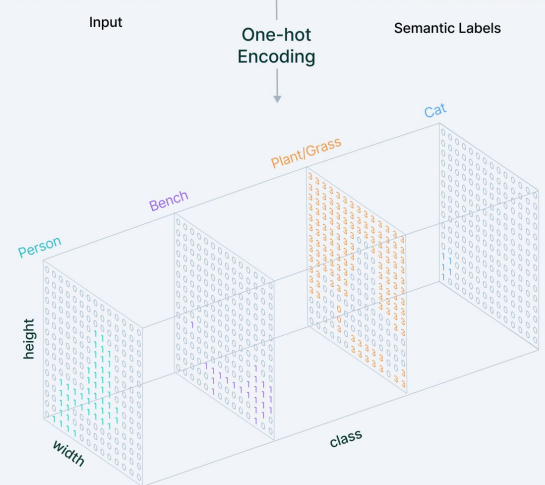
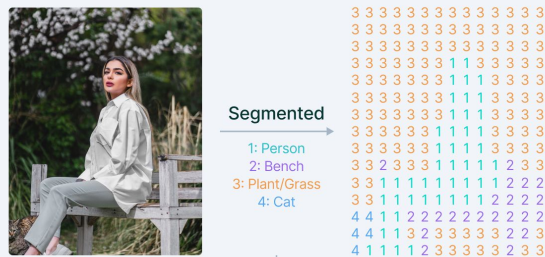
Segmentacja z użyciem głębokich sieci neuronowych

Convolutional encoder-decoder



[Image Segmentation: Deep Learning vs Traditional \[Guide\]](#)

An overview of Semantic Image Segmentation



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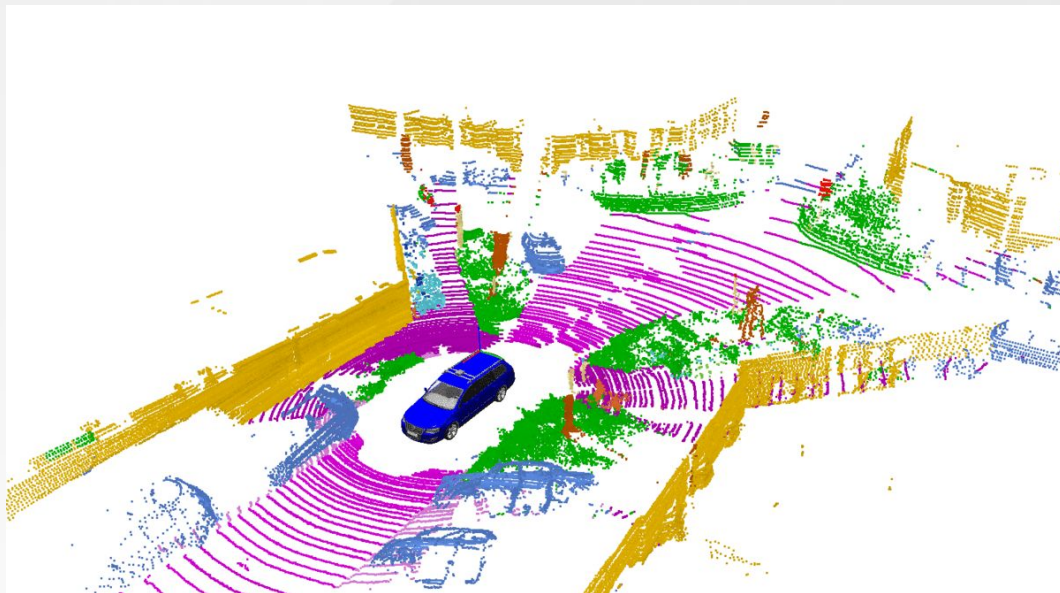
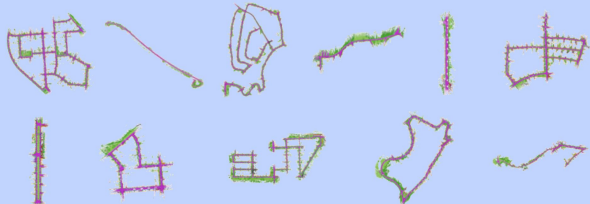
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<https://github.com/PRBonn/lidar-bonnetal?tab=readme-ov-file>



SemanticKITTI dataset

TRAINING SET





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RangeNet++

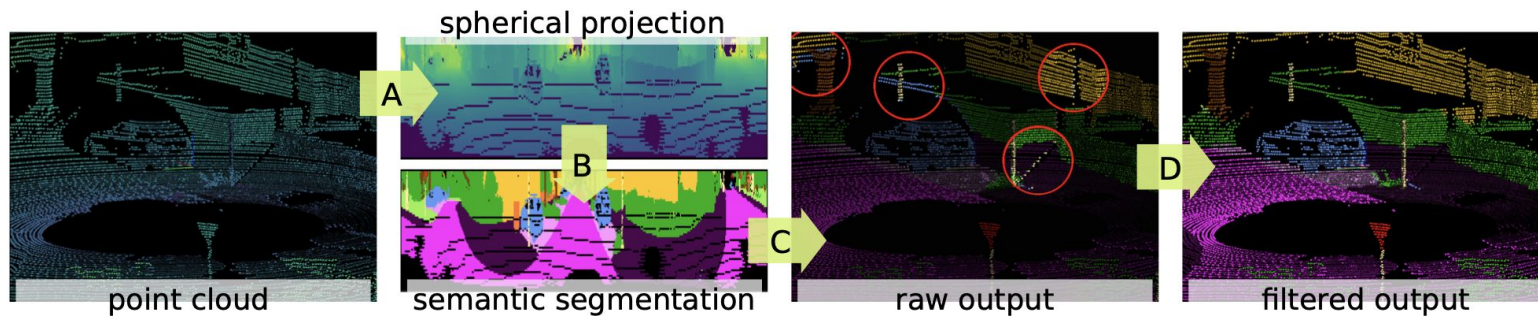
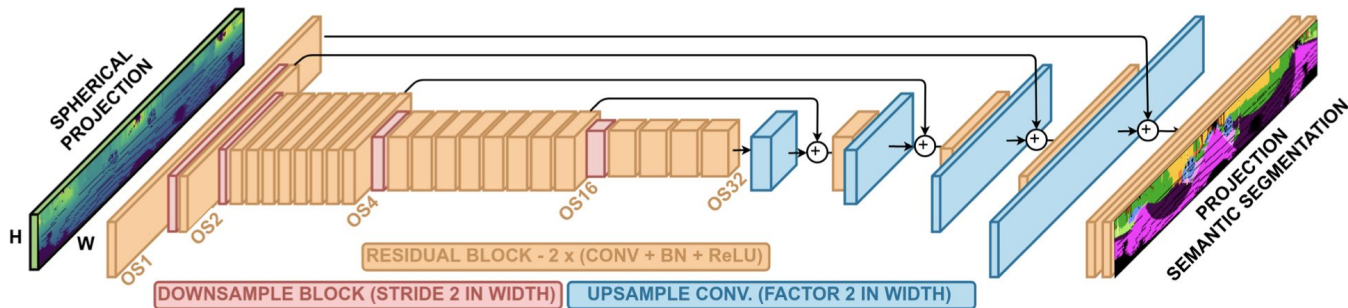


Fig. 2: Block diagram of the approach. Each of the arrows corresponds to one of our modules.





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<https://arxiv.org/pdf/2312.10035>



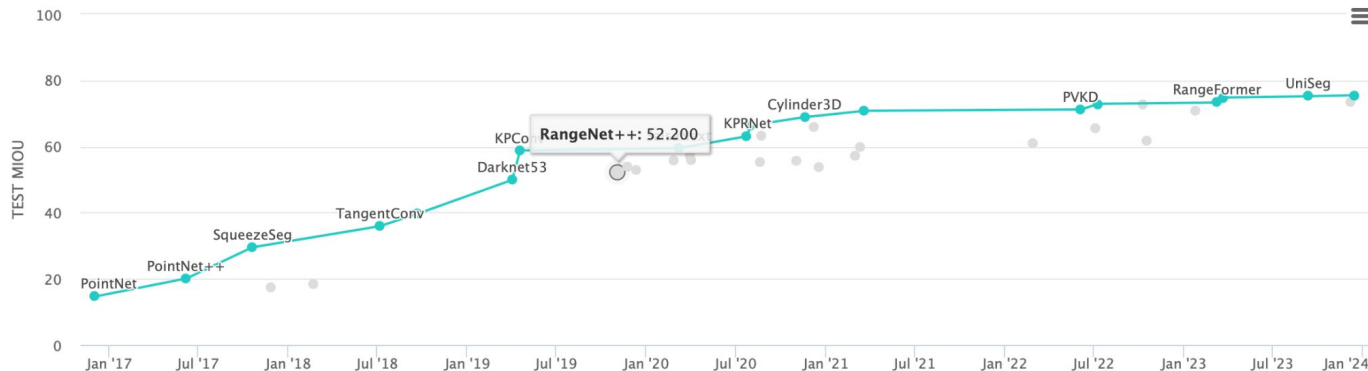
SOTA semantic segmentation

3D Semantic Segmentation on SemanticKITTI

Leaderboard

Dataset

View by for





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Materialy

- [Overview of 3D Object Representations](#)
- [From Pixels to 3D Shapes: An Overview of 3D Data Representations | by Dedeepya Lekkala | Medium](#)
- [How to represent 3D Data](#)
- [Image Segmentation: Deep Learning vs Traditional \[Guide\]](#)
- [An Intuitive Introduction to Point Net](#)

