EdgeNet: Semantic Scene Completion from a Single RGB-D Image

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Surrey, UK
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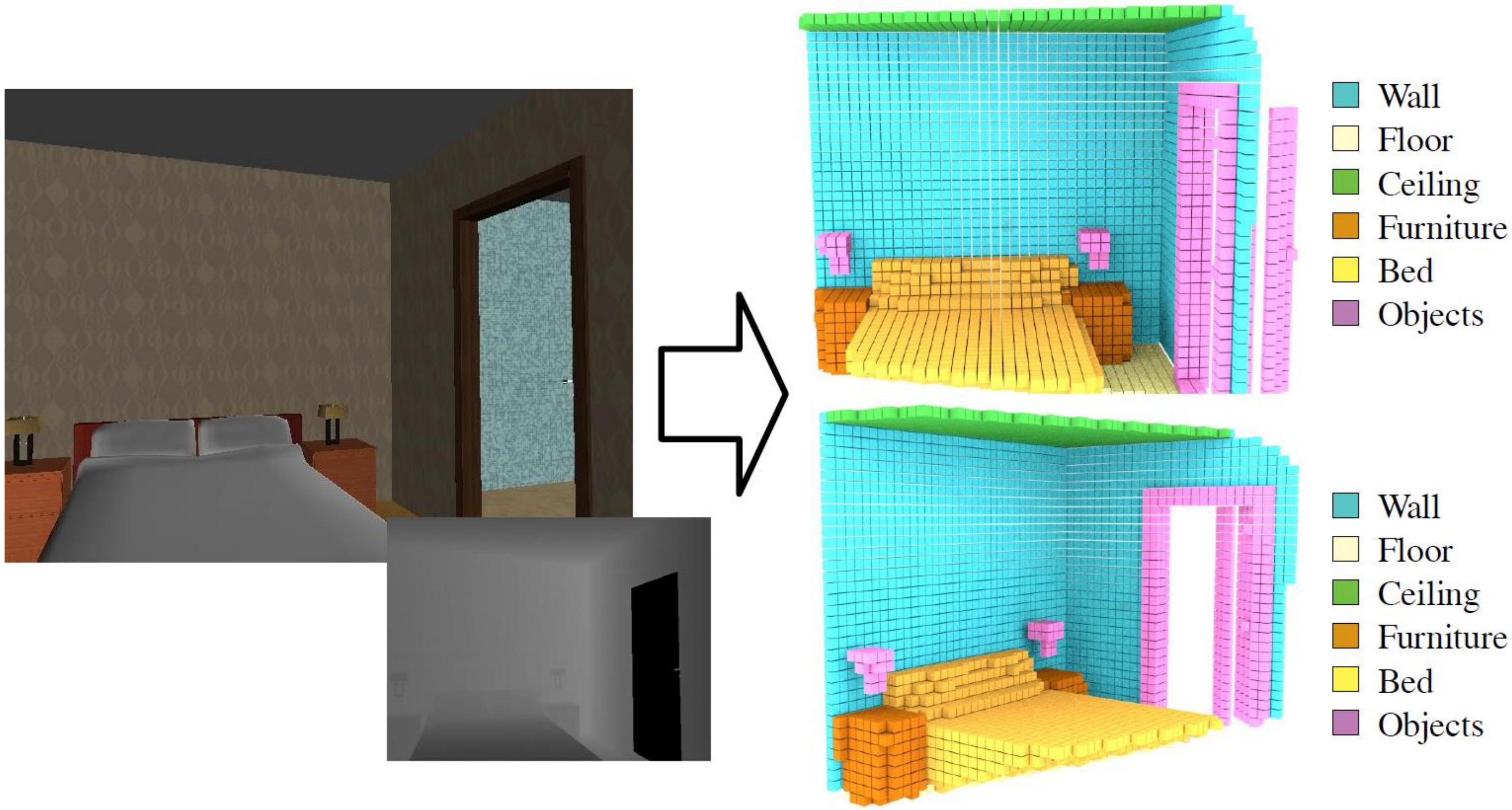
Milan, January 2021

Semantic Scene Completion



Introduced by Song *et al*.[1] in 2017

Trained a 3D CNN that jointly deals with completion and semantic segmentation

[1] Song, S., Yu, F., Zeng, A., Chang, A.X., Savva, M., and Funkhouser, T.: Semantic Scene Completion from a Single Depth Image. In Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Honolulu, Hawaii, July 21-26, pp. 190–198, Piscataway, NJ, July 2017. IEEE.

Previous Works

Depth maps only

- SSCNET: Song et al. [1]

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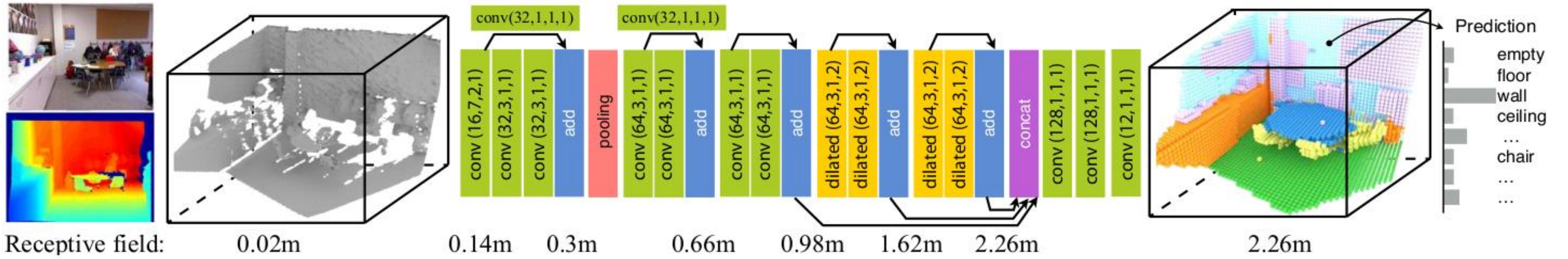
- SSCNET: Song et al. [1]
    - Encoder-decoder network architecture



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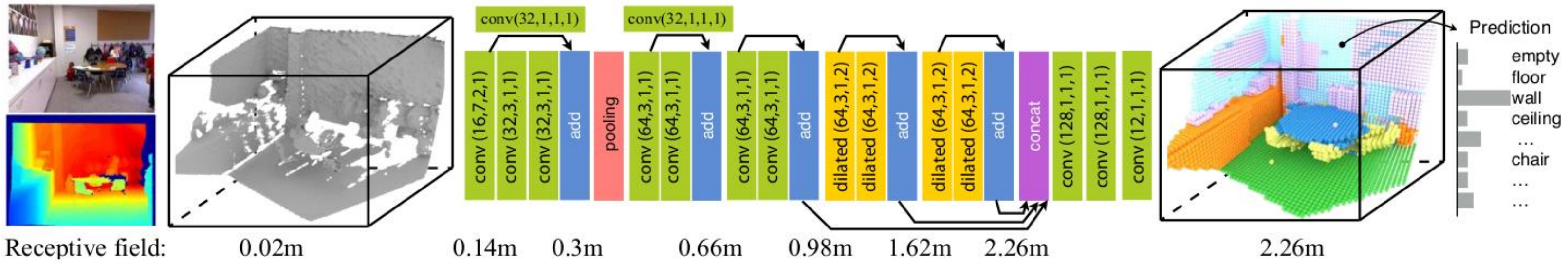
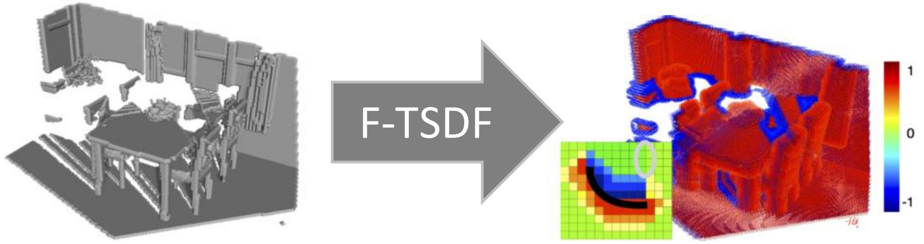
- SSCNET: Song et al. [1]
  - Encoder-decoder network architecture
  - Proposed F-TSDF encoding





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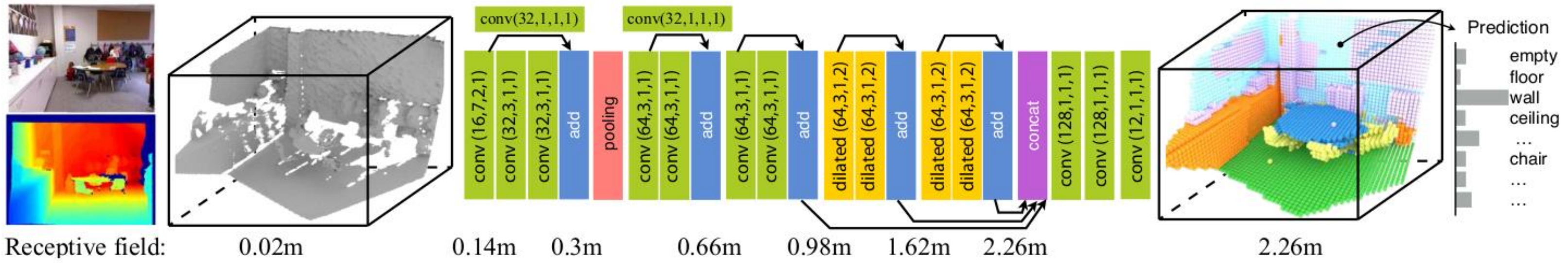
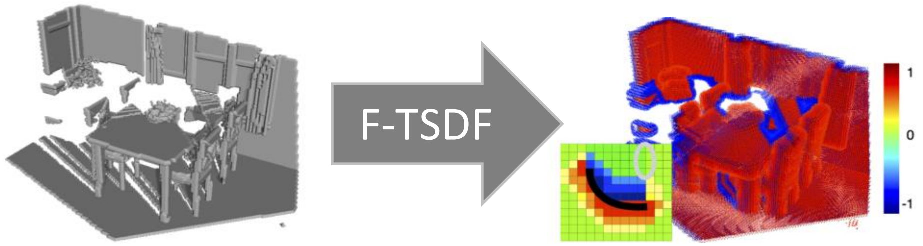
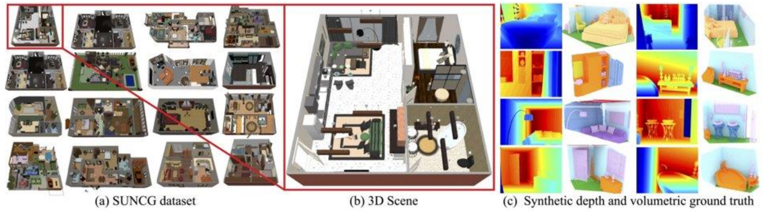
Depth maps only

- SSCNET: Song et al. [1]
  - Encoder-decoder network architecture
  - Proposed F-TSDF encoding
  - Introduced SUNCG Dataset




F-TSDF

SUNCG



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- SSCNET: Song et al. [1]
- Guo and Tong [2]:
  - 2D features projected to 3D

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[2] Guo, Y. and Tong, X.: View-Volume Network for Semantic Scene Completion from a Single Depth Image. In Proceedings of the Twenty-Seventh International Joint Conference on Artificial Intelligence, pp. 726–732, Stockholm, Sweden, July 2018. International Joint Conferences on Artificial Intelligence Organization, ISBN 978-0-9992411-2-7. https://doi.org/10.24963/ijcai.2018/101.

Previous Works

Depth maps only

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Neglect the RGB channels from the input data

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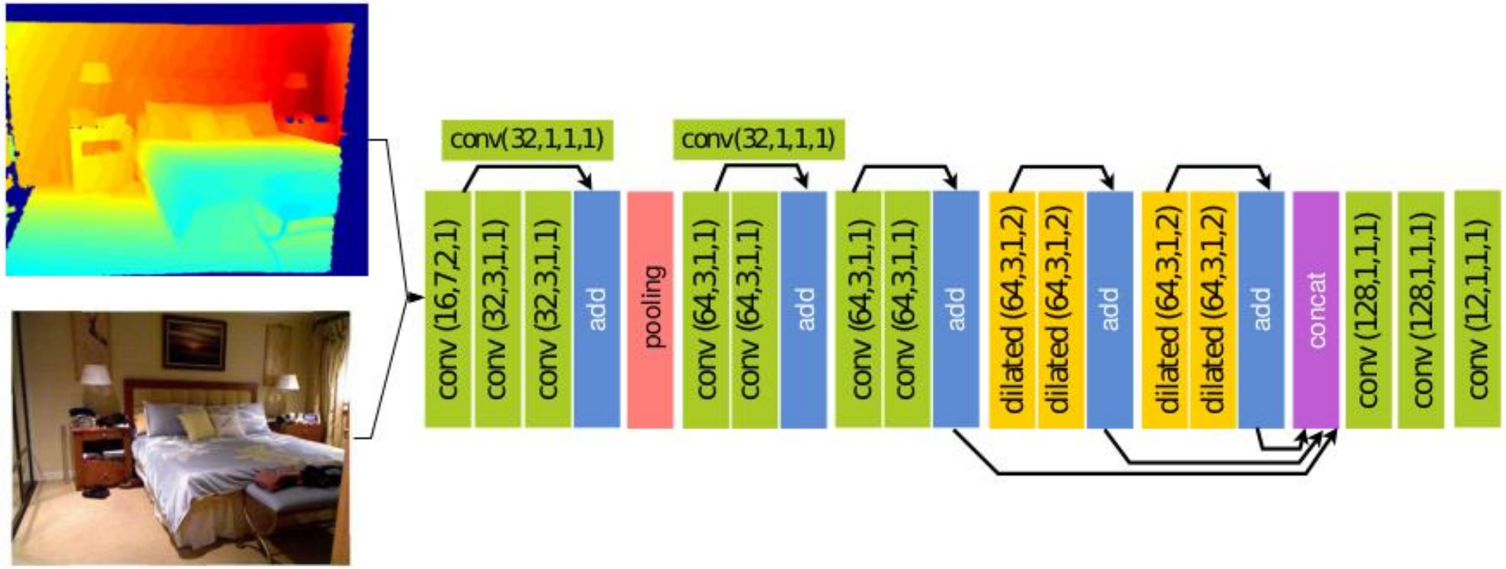
Previous Works

Depth maps plus RGB

- Guedes *et al*.[3]



[3] Guedes, A.B.S., de Campos, T.E., and Hilton, A.: Semantic scene completion combining colour and depth: preliminary experiments. In ICCV workshop on 3D Reconstruction Meets Semantics (3DRMS), Venice, Italy, October 2017. Event webpage: http://trimbot2020.webhosting.rug.nl/events/events-2017/3drms/. Also published at arXiv:1802.04735.

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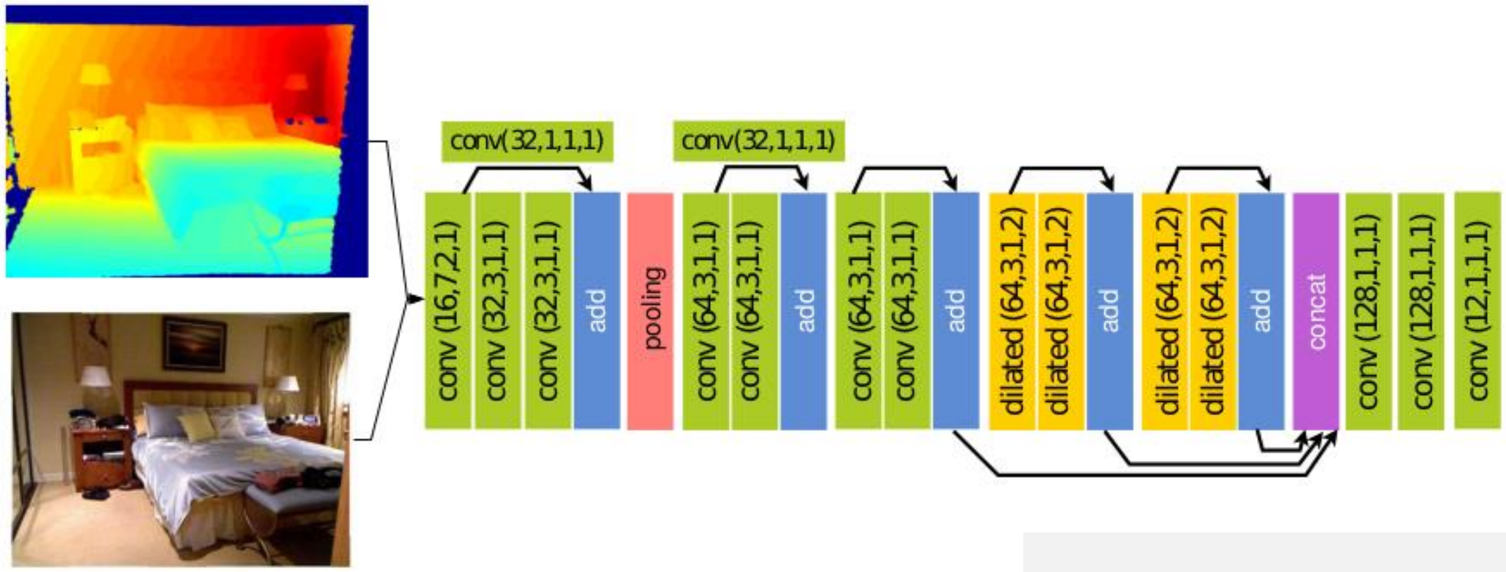

Suffers from RGB data sparsity after projection to 3D

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Previous Works

Depth map plus 2D segmentation

- Two stream 3D semantic scene completion: Garbade *et al*.[4]

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Requires a complex two step training procedure

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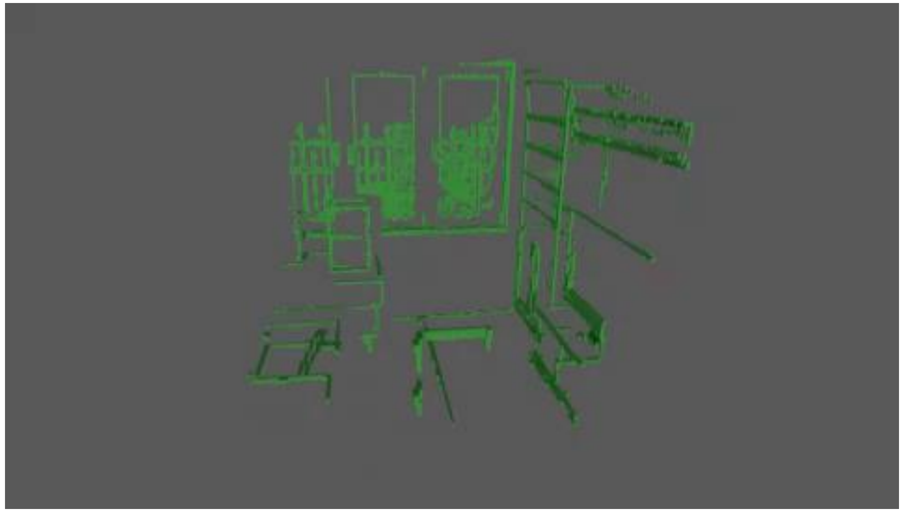
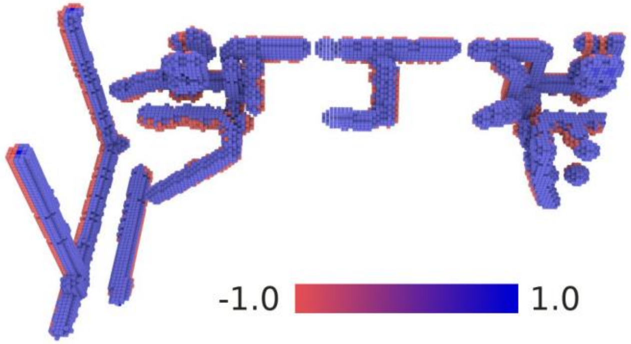
Our Approach: EdgeNet

- We extract boundary information from RGB data and project to 3D...

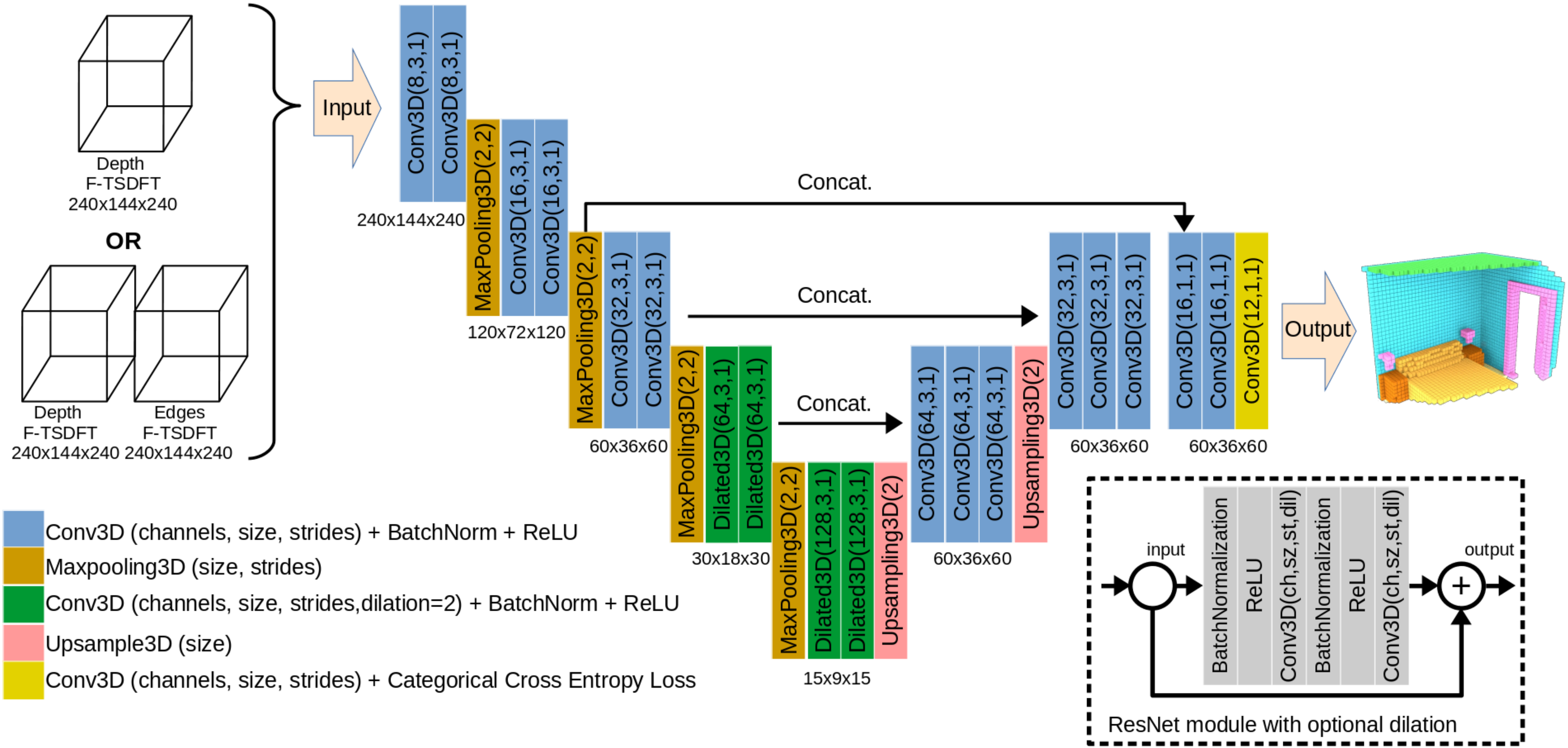


Our Approach: EdgeNet

- ...then, we apply F-TSDF to the projected edge volume



Network Architecture



🟦 Conv3D (channels, size, strides) + BatchNorm + ReLU

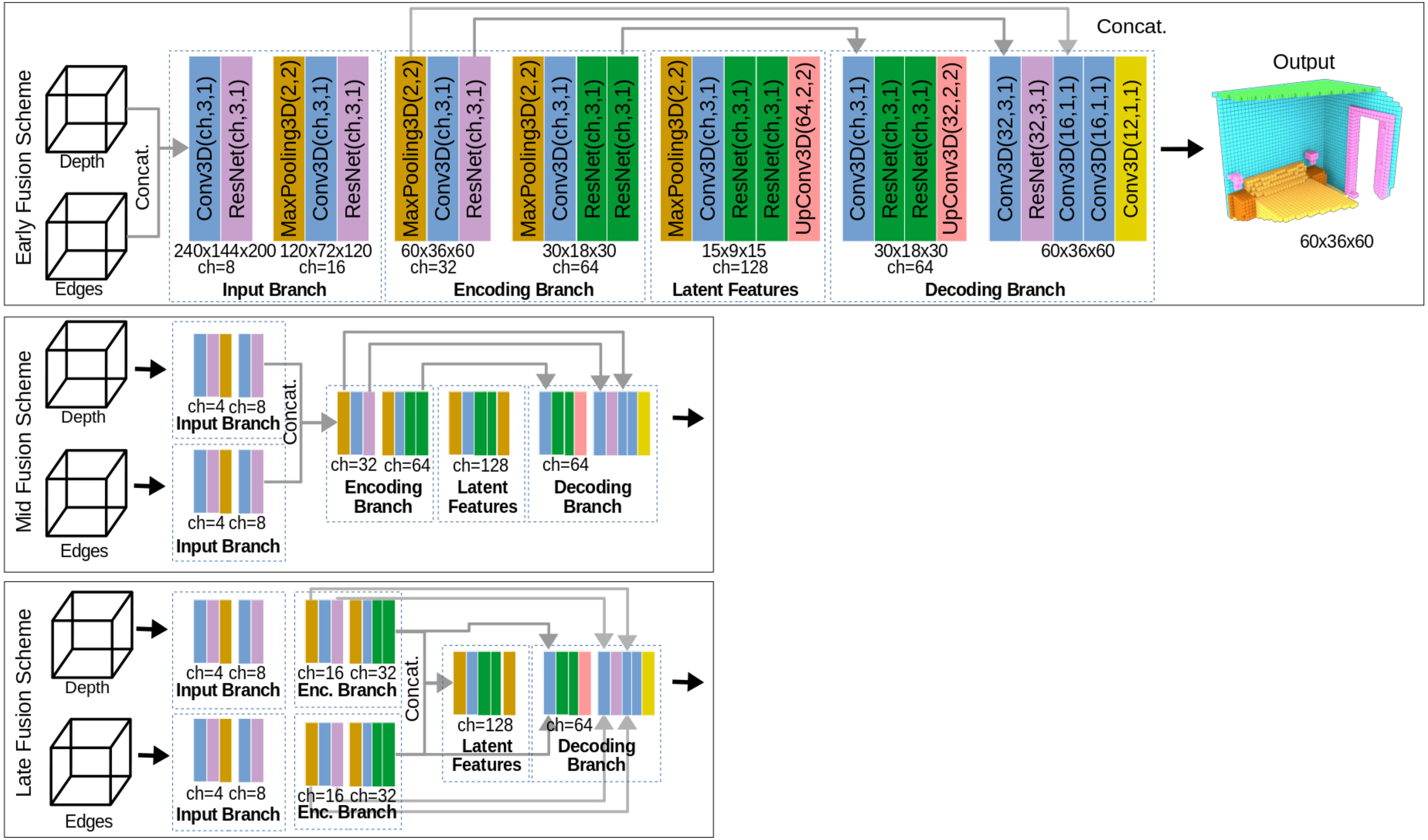
🟫 Maxpooling3D (size, strides)

🟩 Conv3D (channels, size, strides,dilation=2) + BatchNorm + ReLU

🟥 Upsample3D (size)

🟨 Conv3D (channels, size, strides) + Categorical Cross Entropy Loss

Network Architecture - Fusion Schemes



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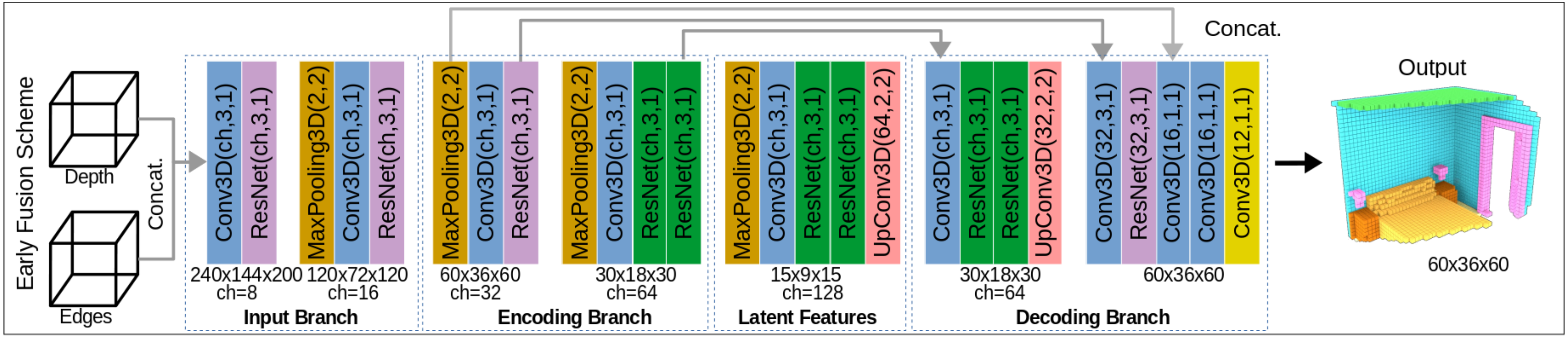

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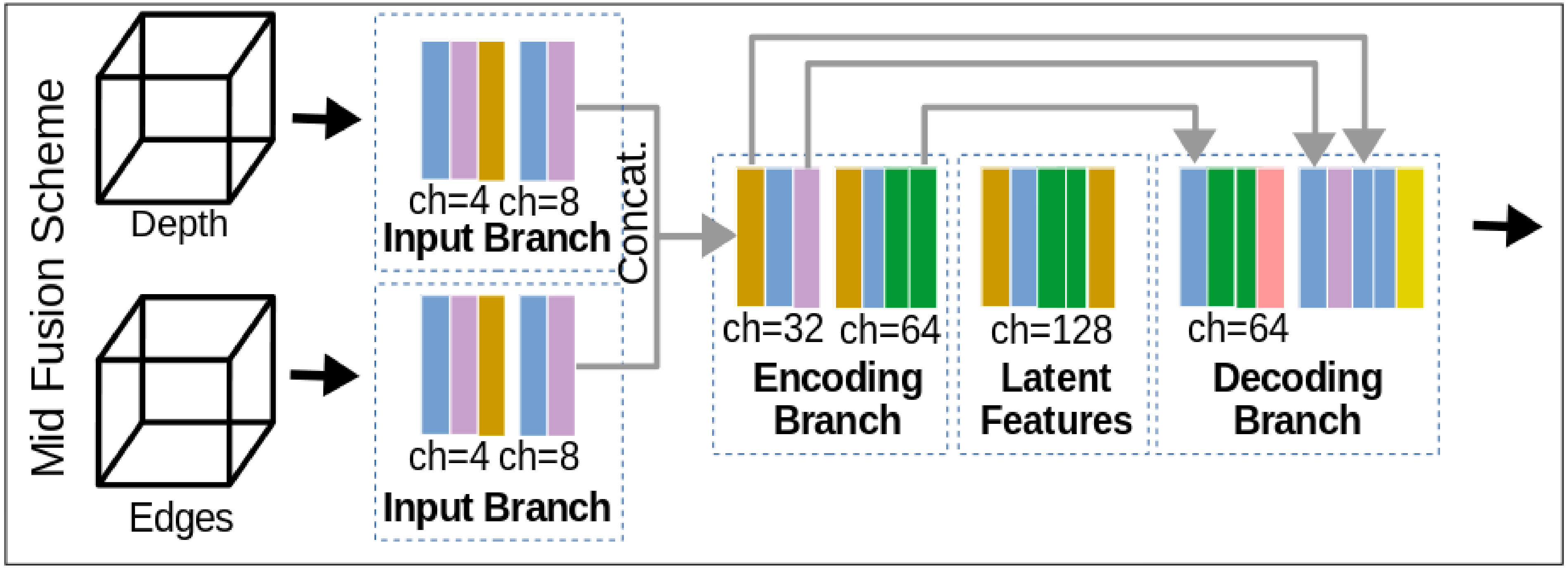

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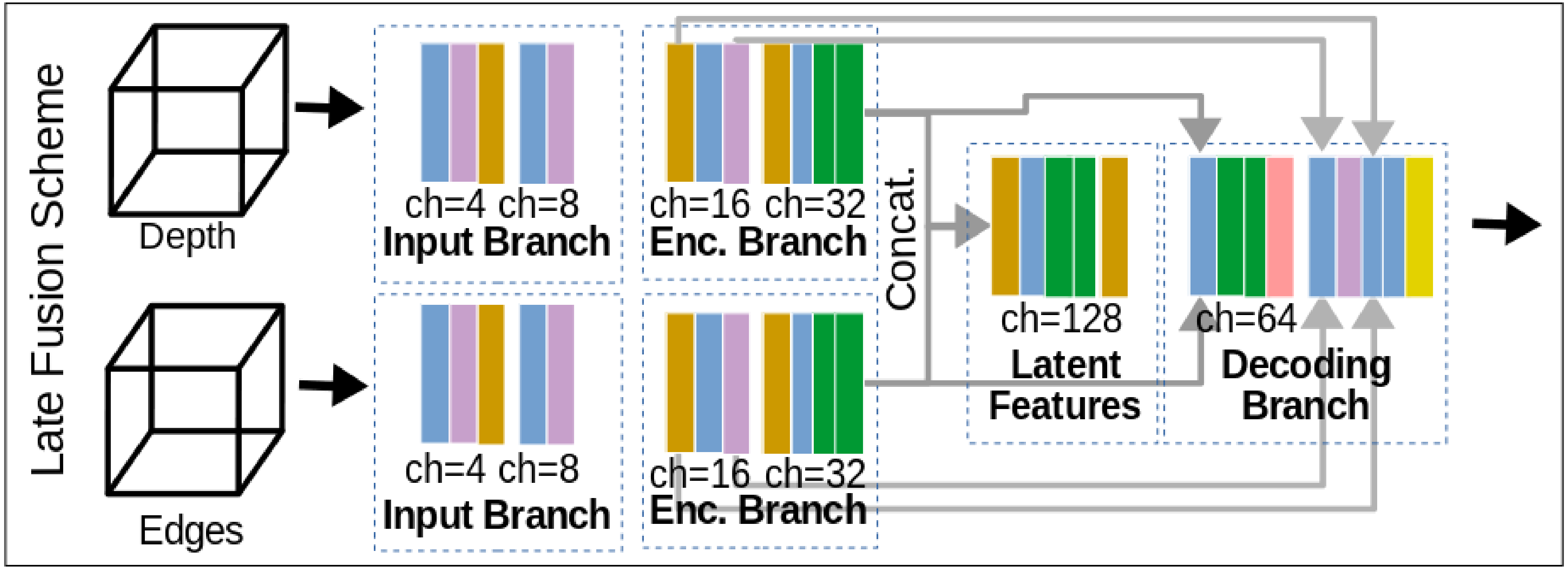

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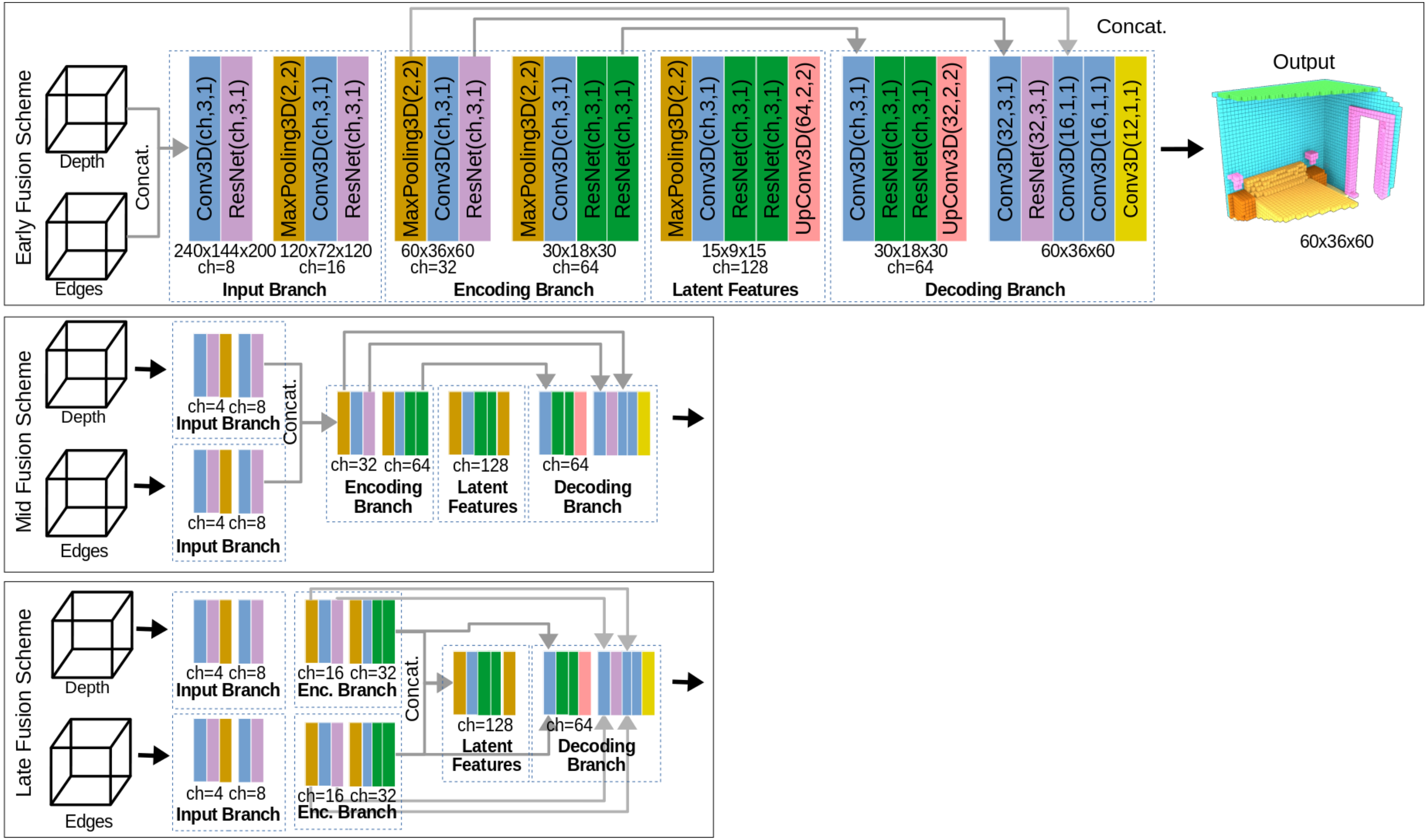

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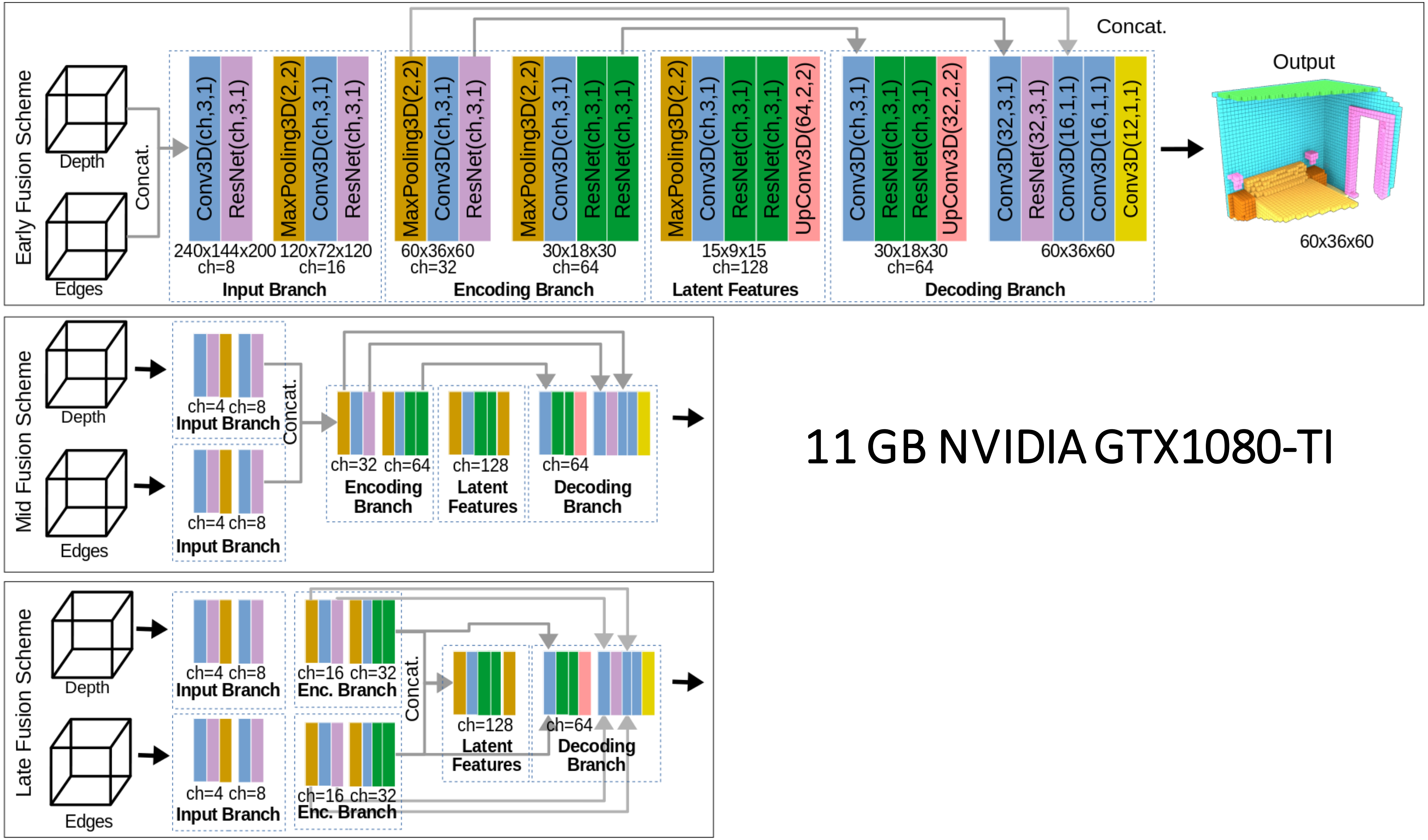


11 GB NVIDIA GTX1080-TI

Datasets

- SUNCG*

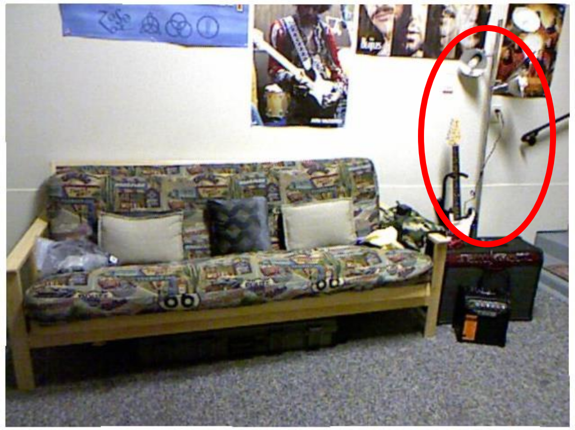
(a) SUNCG dataset (b) 3D Scene (c) Synthetic depth and volumetric ground truth

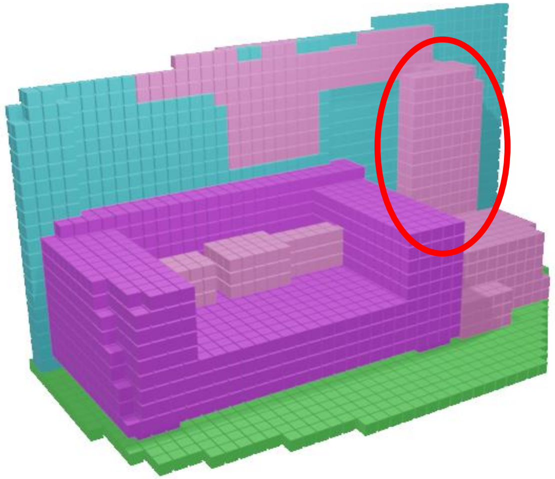
- NYUDv2**

Quantitative Results

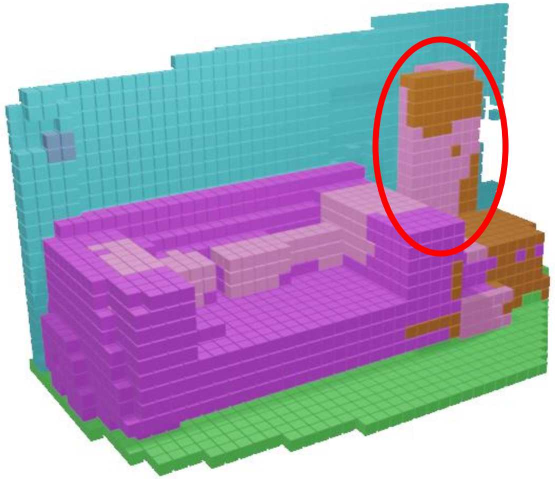
- SUNCG
  - New state-of-the-art result (70.3% avg. IoU)
- NYUD-V2
  - Our solution surpassed previous end-to-end approaches (33.7% avg. IoU)
  - EdgeNet's results are similar to non end-to-end solutions, with a much simpler training pipeline.
- Best Fusion Scheme: Mid Fusion (EdgeNet-MF)

Qualitative Results

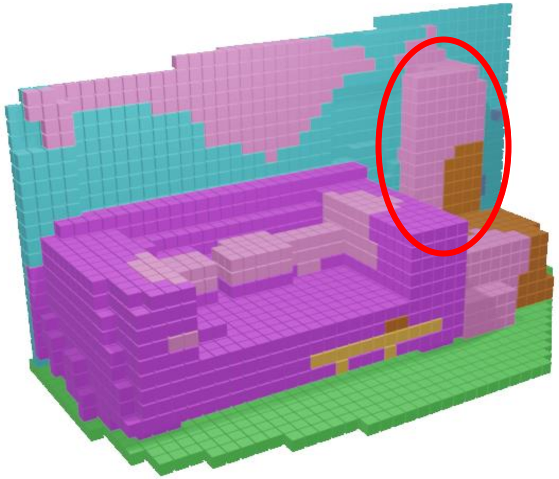




Ground Truth



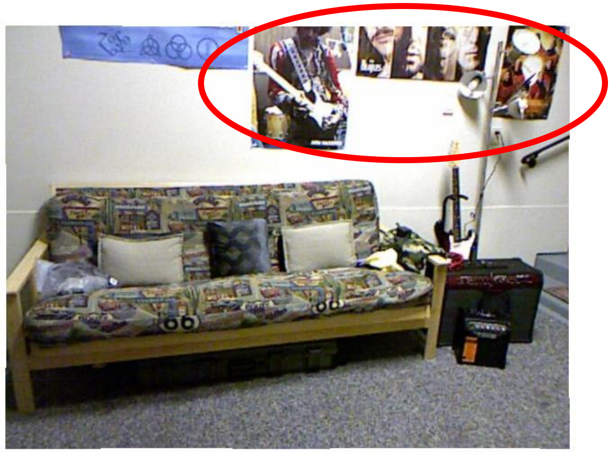
SSCNet

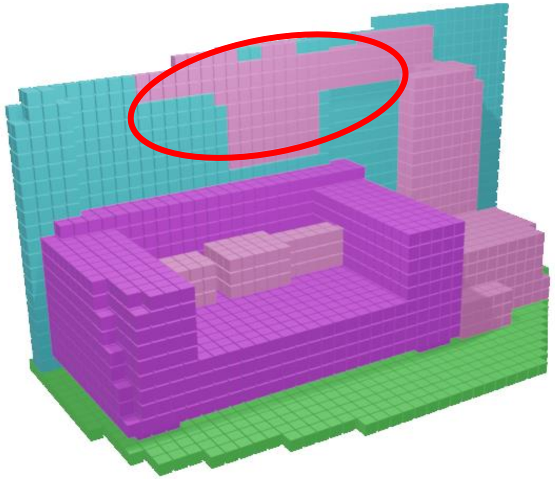


EdgeNet-MF

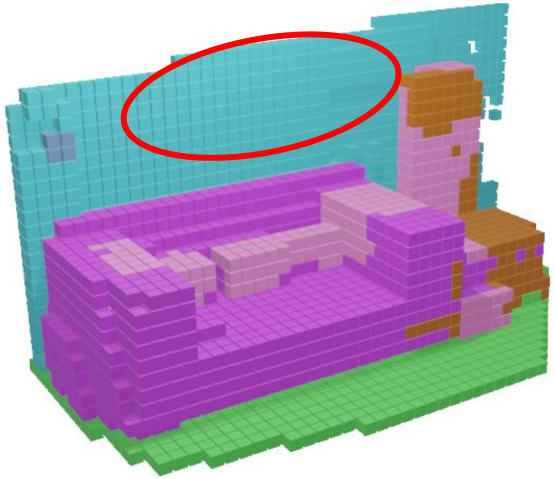
Higher overall accuracy

Qualitative Results

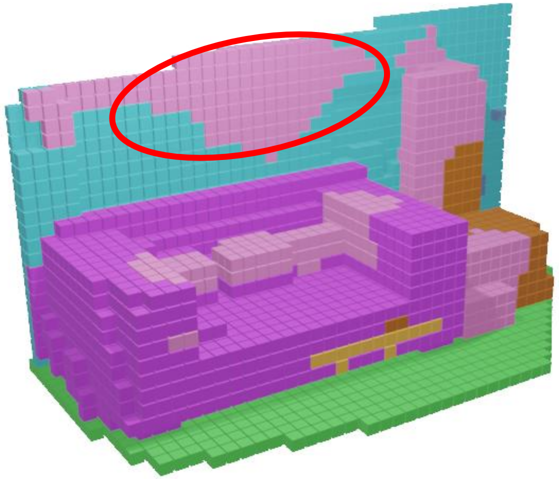




Ground Truth



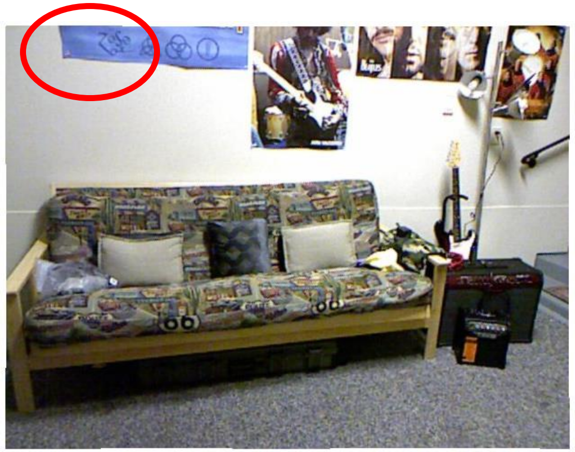
SSCNet

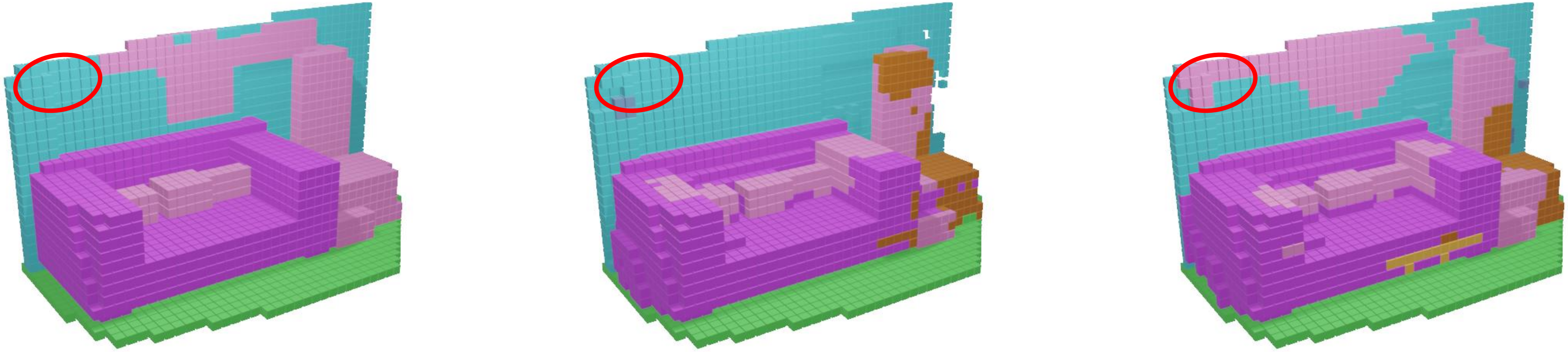


EdgeNet-MF

Hard-to-detect classes

Qualitative Results





Ground Truth

SSCNet

EdgeNet-MF

NYU Ground Truth errors

Conclusions

- A new end-to-end network architecture
- A new strategy to encode data from RGB channels
- Visually perceptible improvements in 3D
- Improvement over the state-of-the-art result on SUNCG
- We surpassed other end-to-end approaches on NYUDv2

Thank you!