

# **Efficient 3-D Scene Analysis from Streaming Data**

Hanzhang Hu

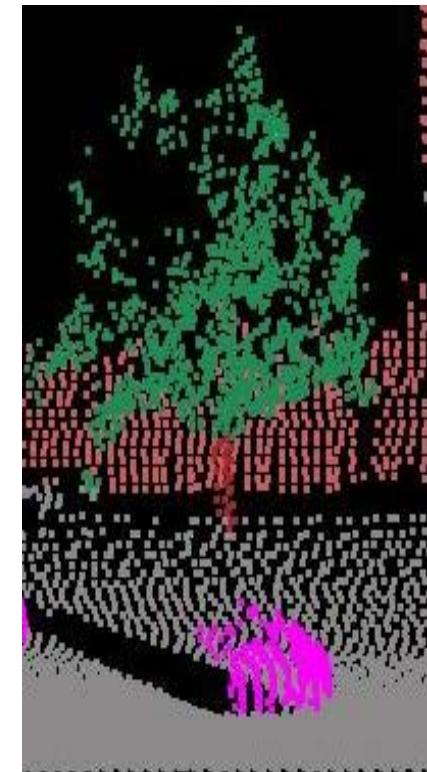
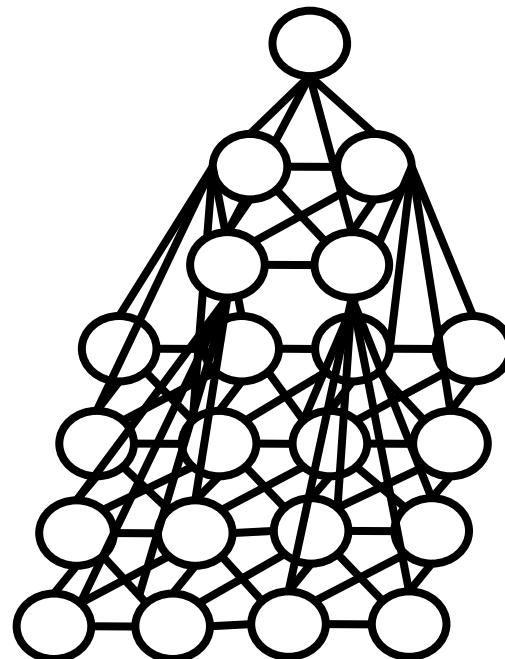
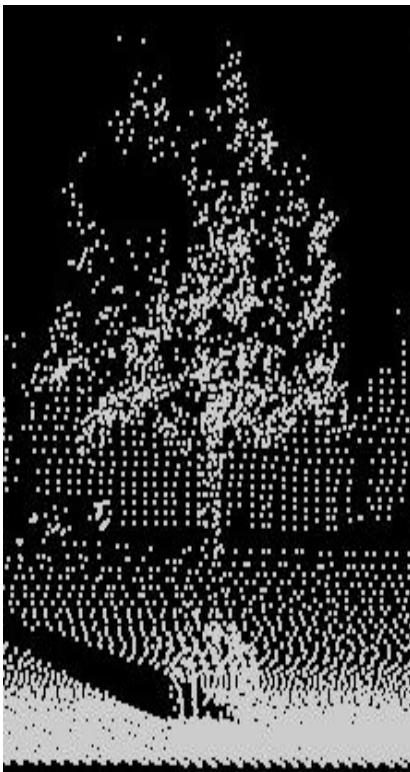
**Daniel Munoz**

J. Andrew Bagnell

Martial Hebert

**Carnegie Mellon**  
**THE ROBOTICS INSTITUTE**

# Scene Parsing

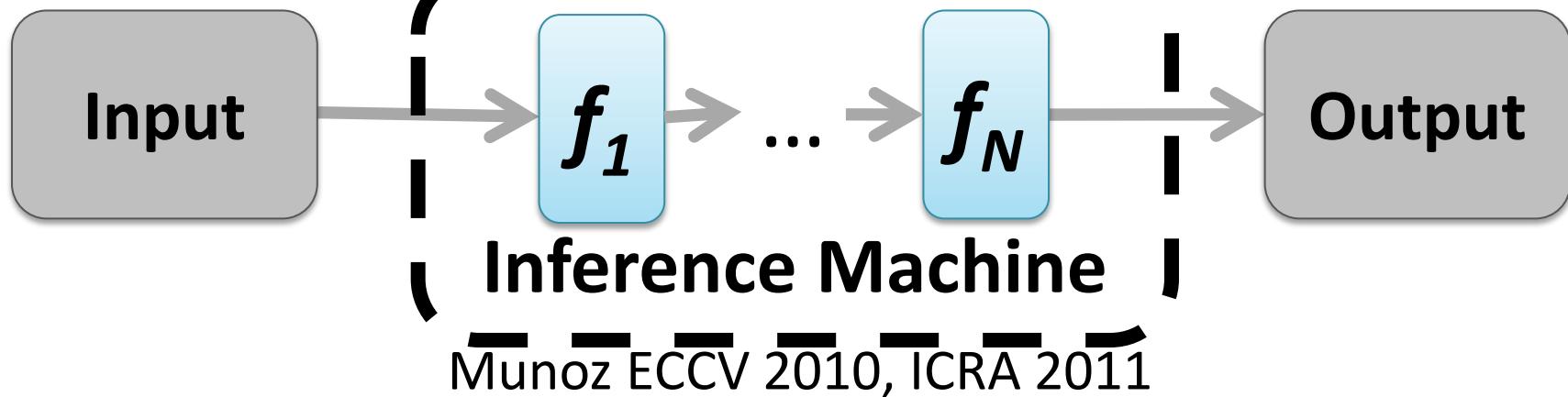
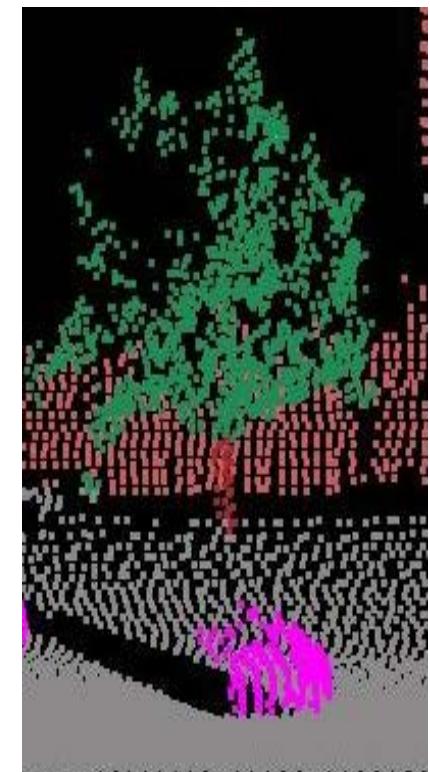
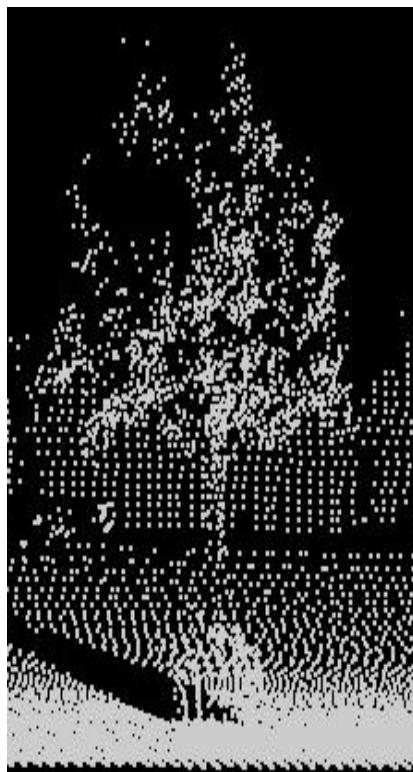


Input

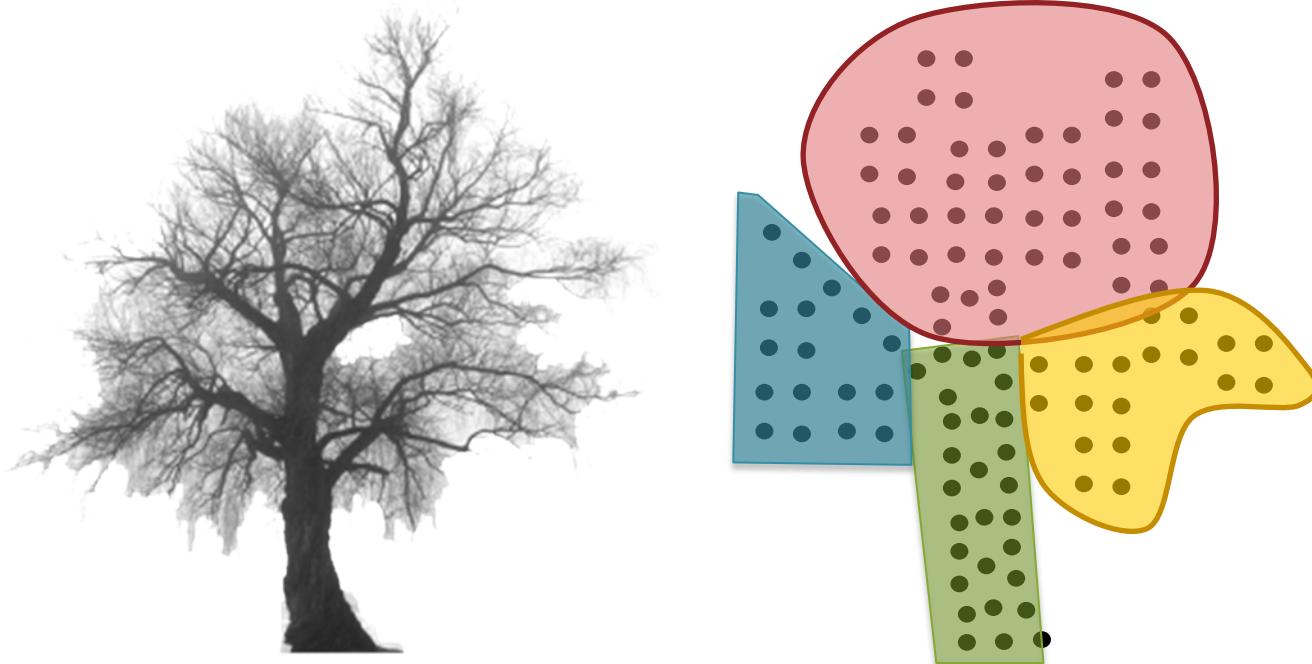
**Belief  
Propagation**

Output

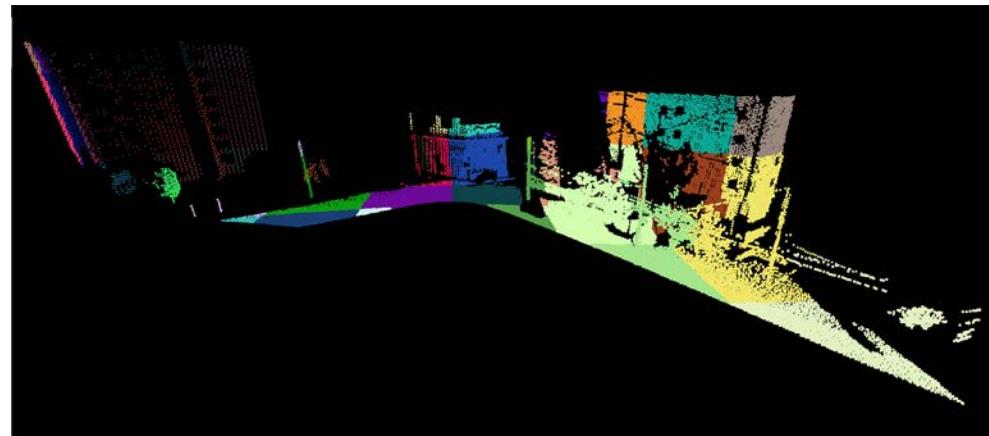
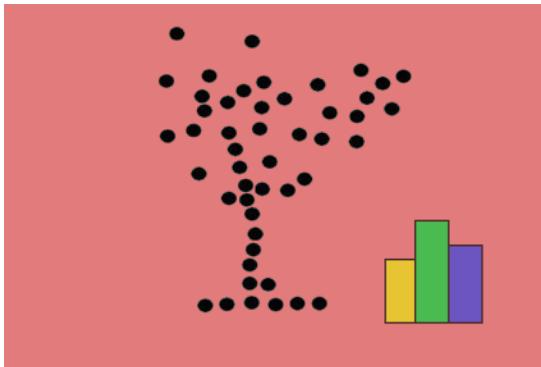
# Scene Parsing



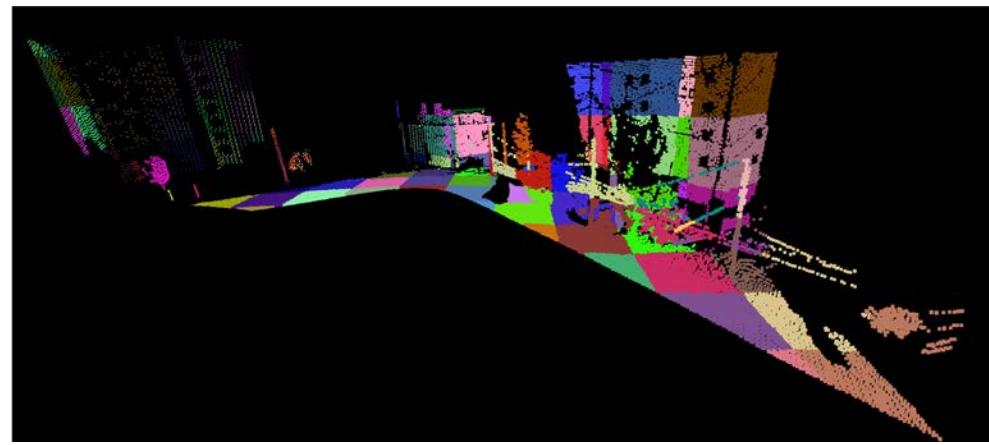
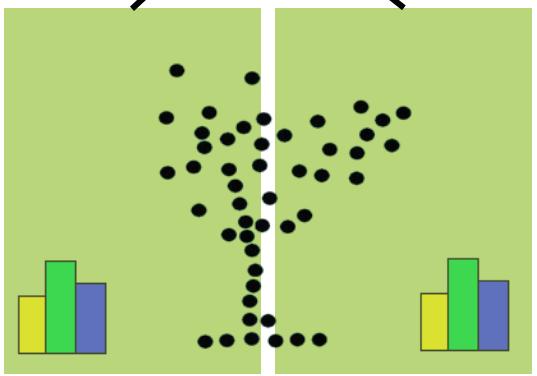
# Region-based Scene Parsing



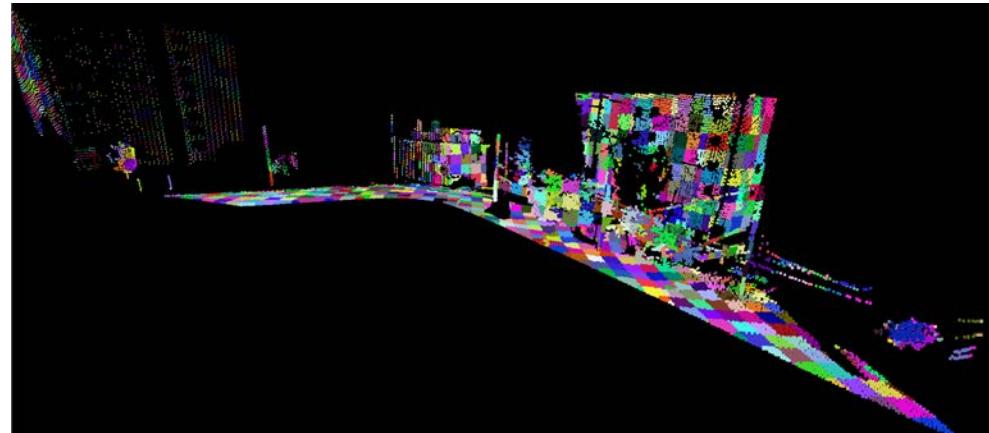
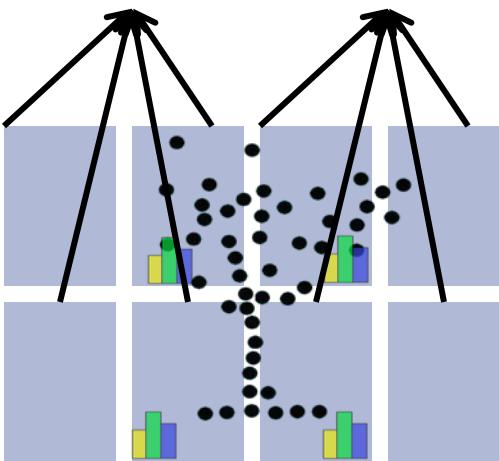
Level 3



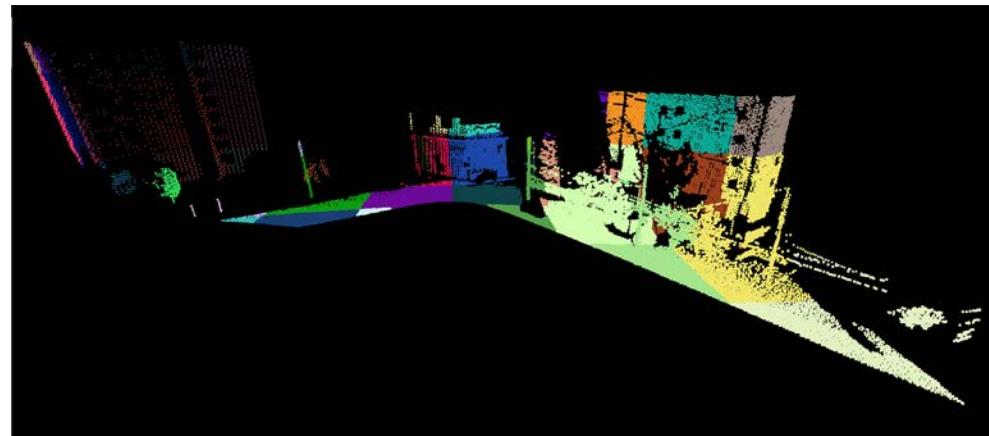
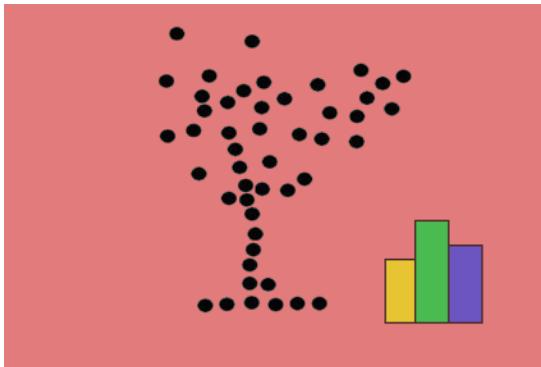
Level 2



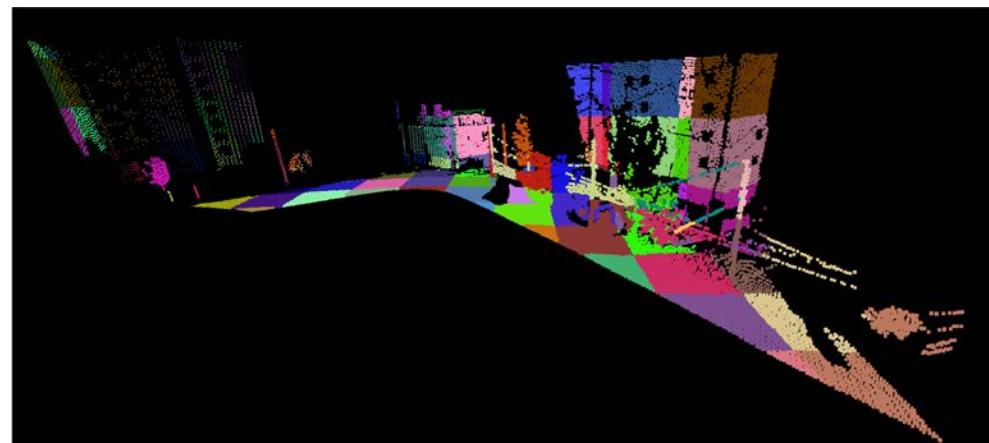
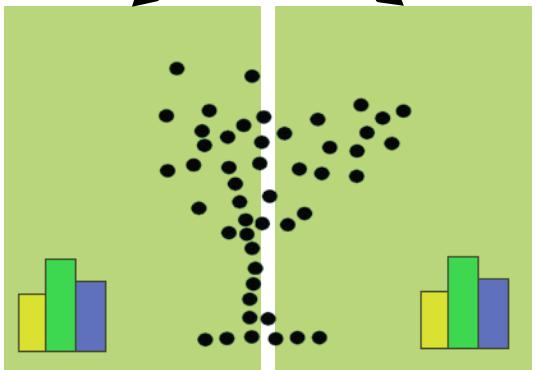
Level 1



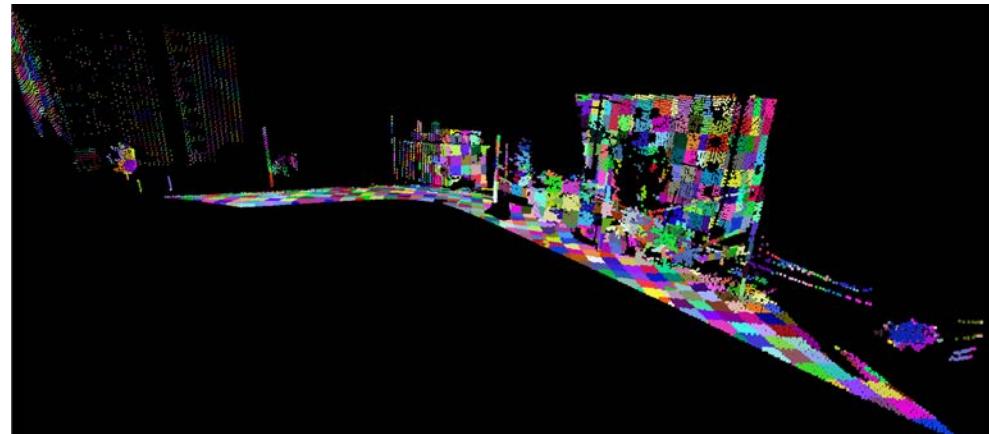
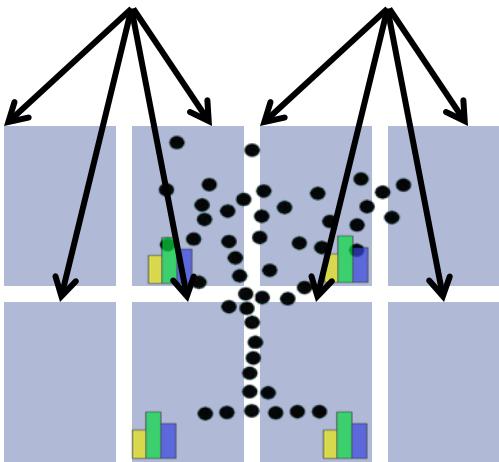
Level 3



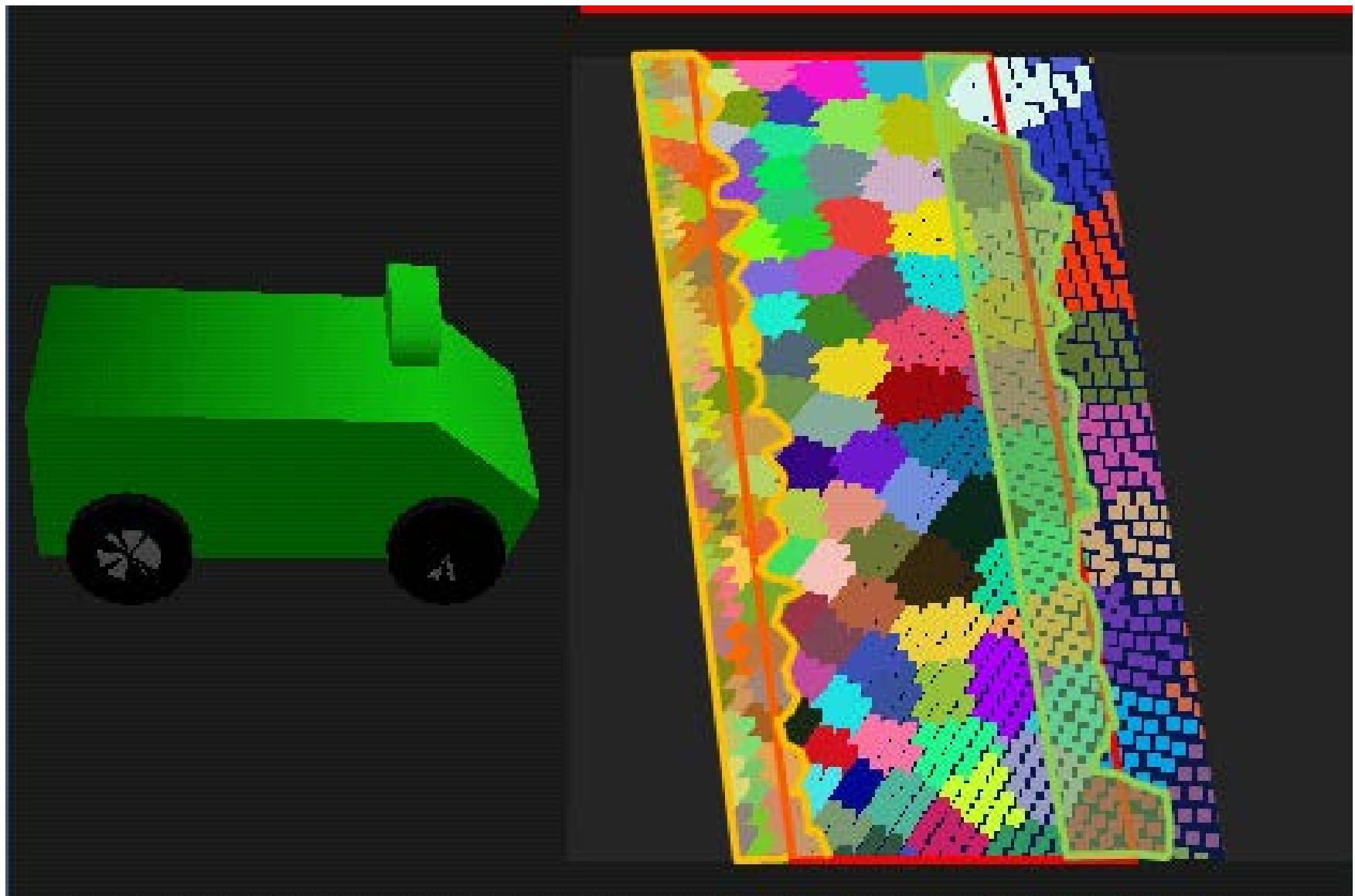
Level 2



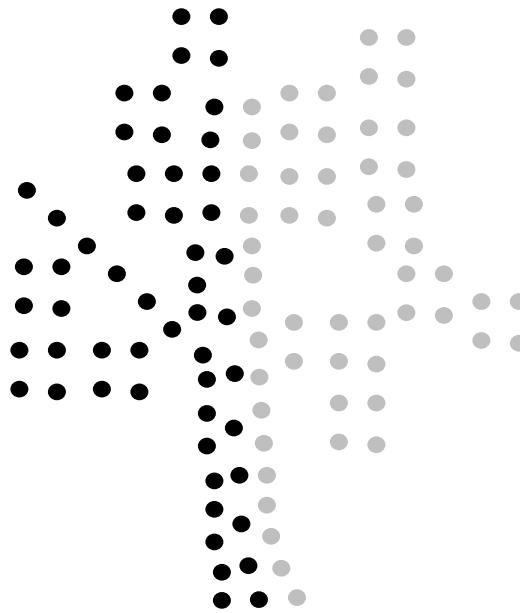
Level 1



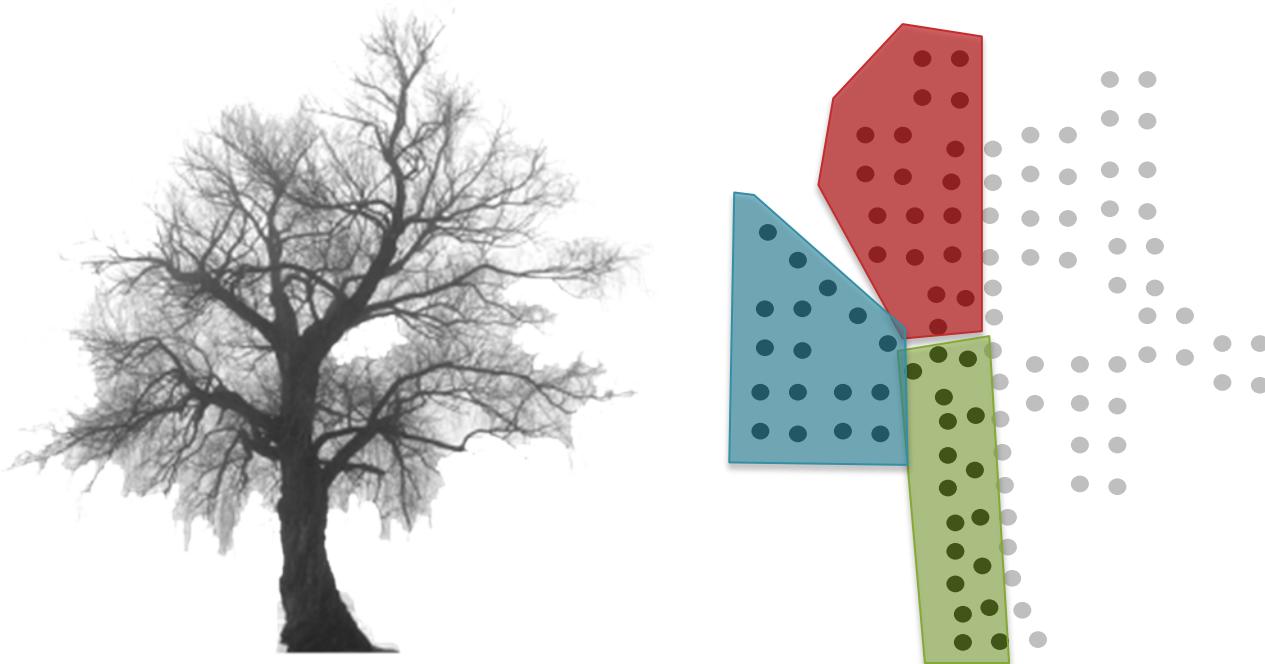
# Streaming 3-D Data



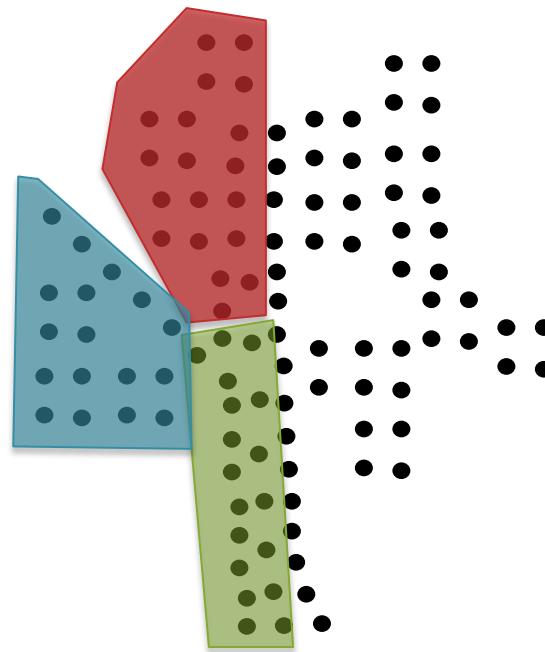
# Streaming Segmentation



# Streaming Segmentation

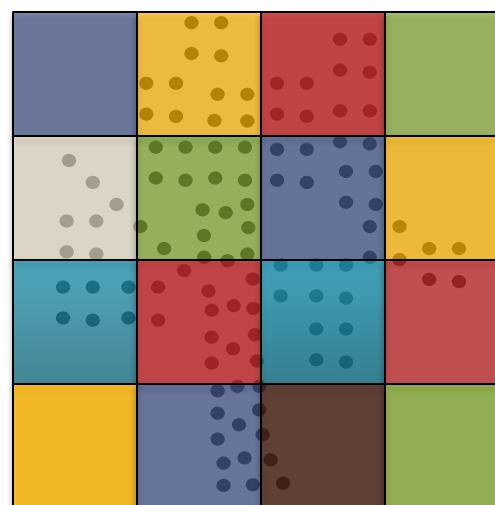
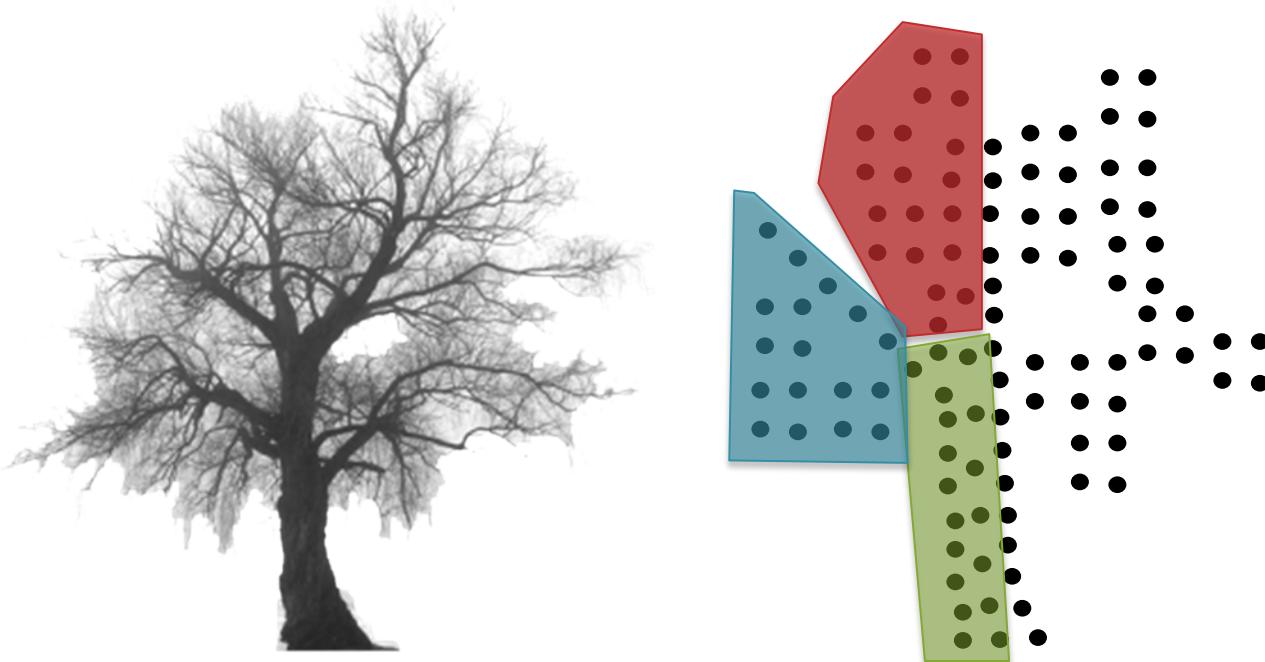


# Streaming Segmentation



?

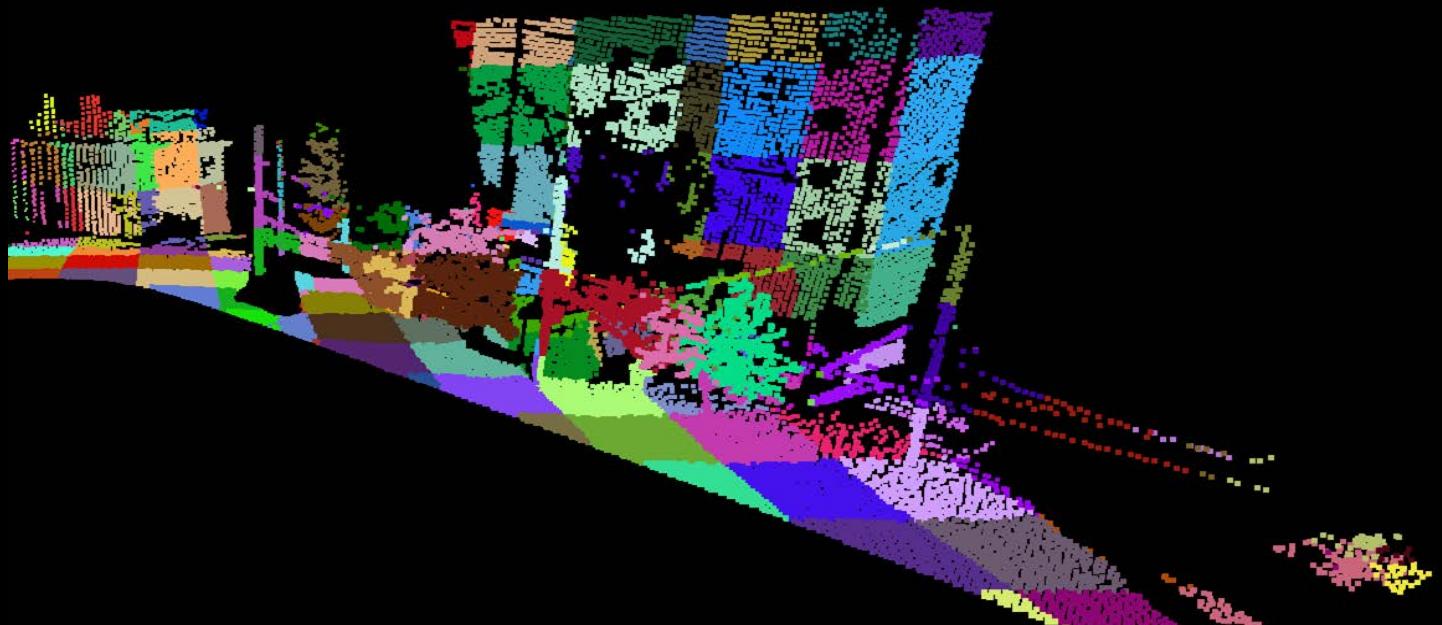
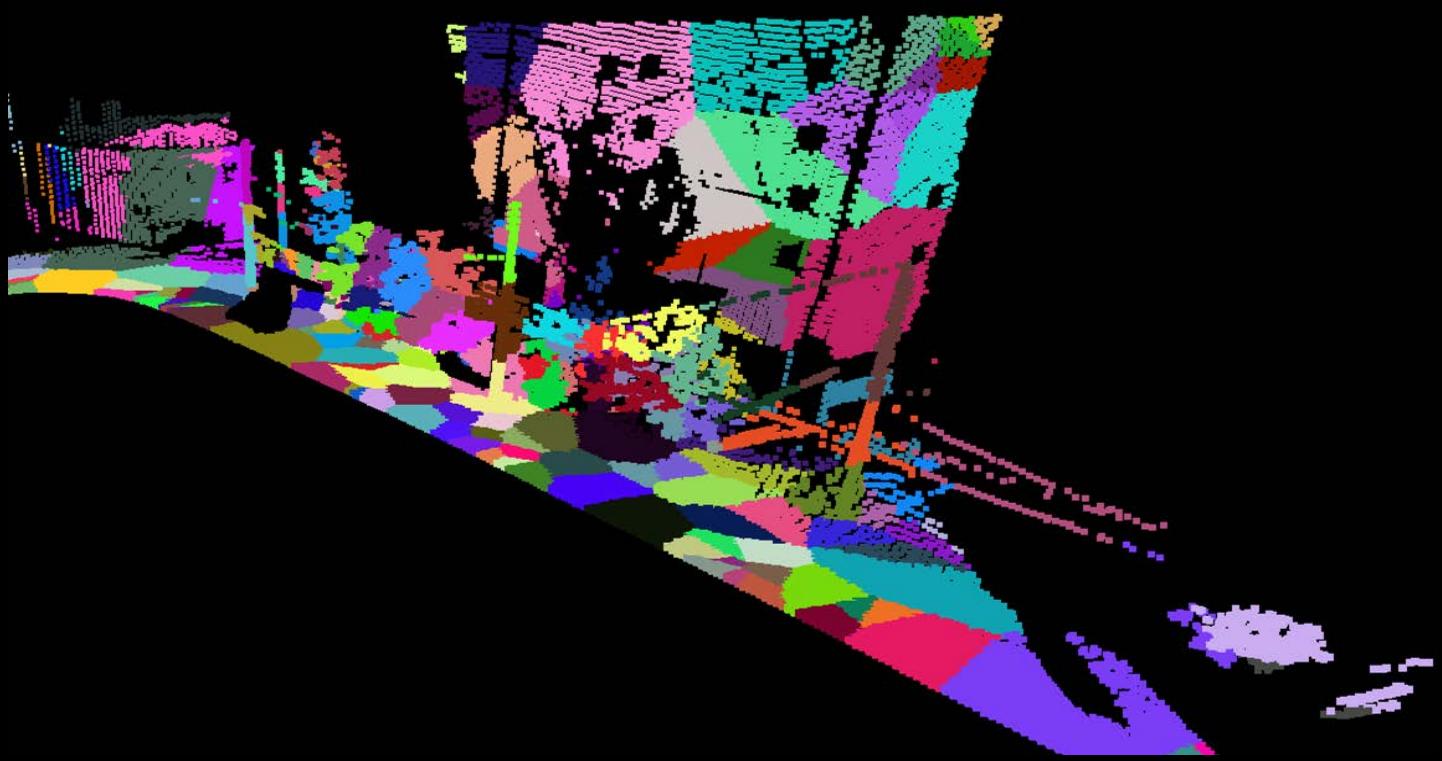
# Streaming Segmentation



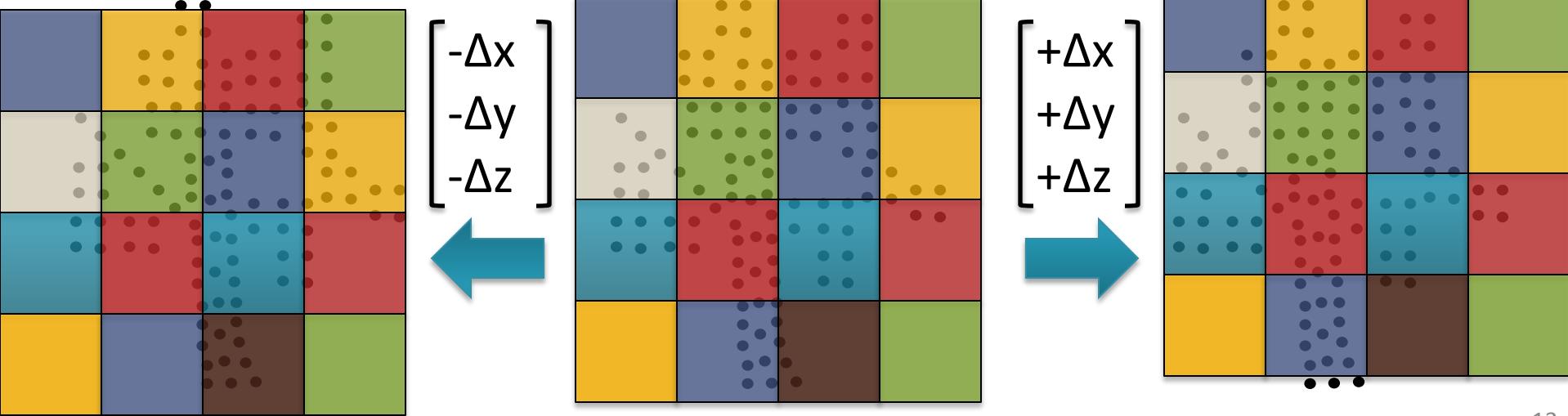
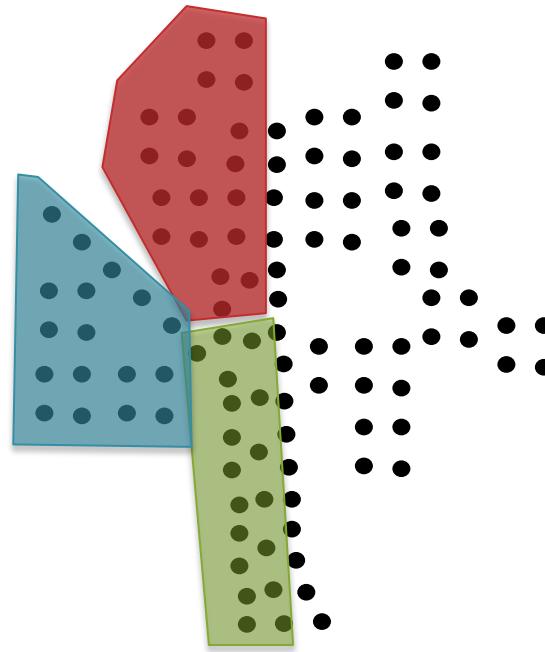
F-H

IJCV 2004

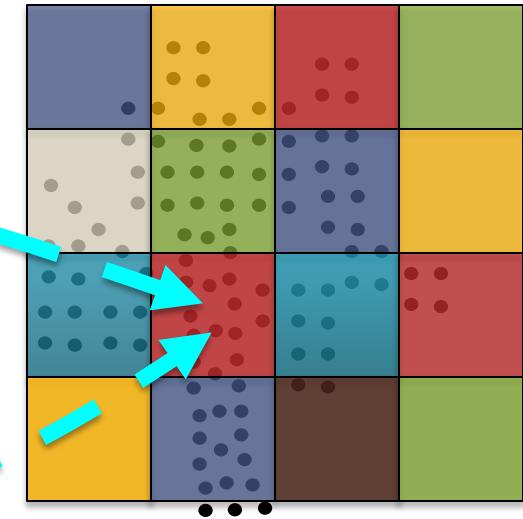
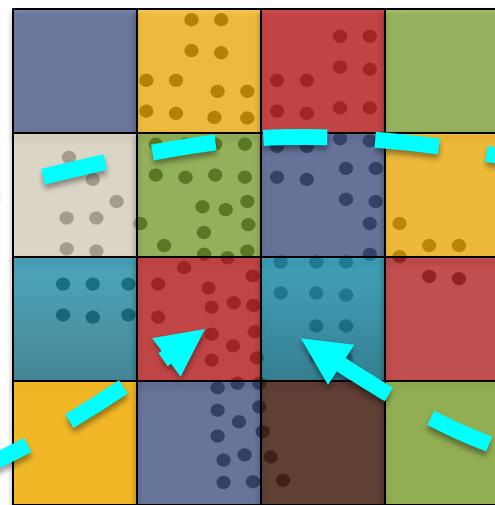
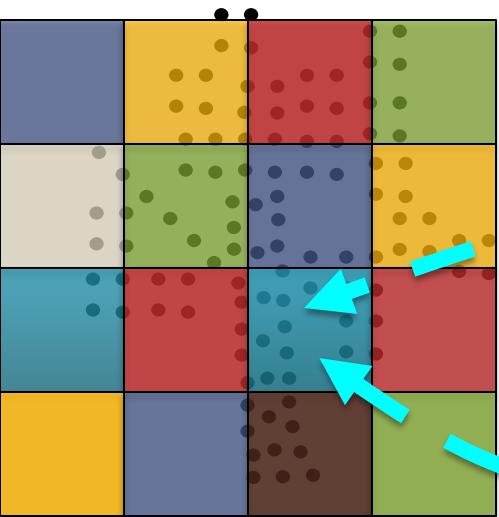
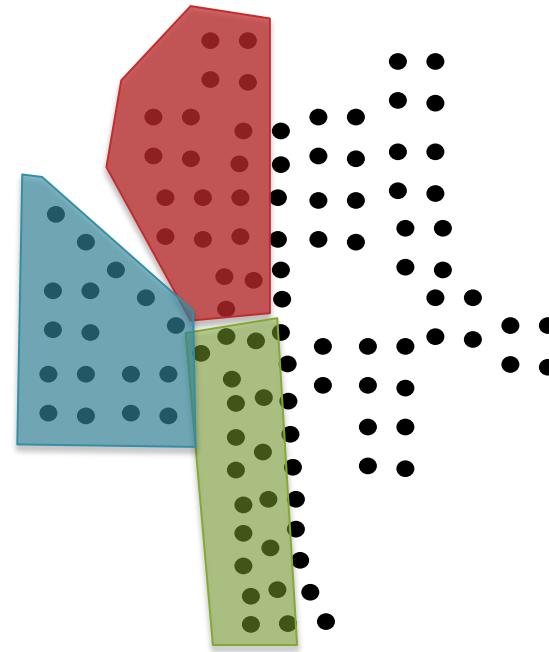
Grid



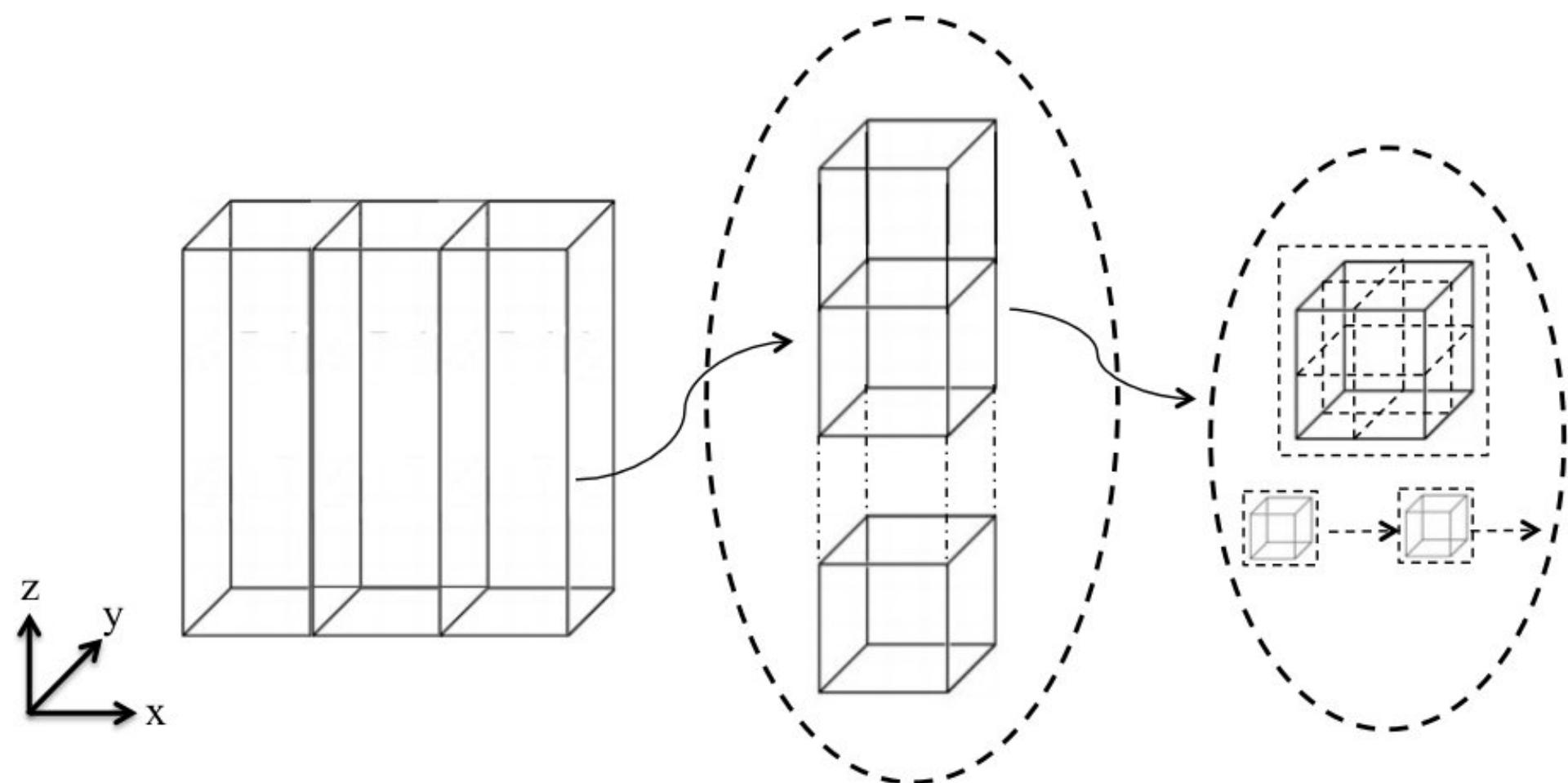
# Streaming Segmentation



# Streaming Segmentation



# World Grid Map

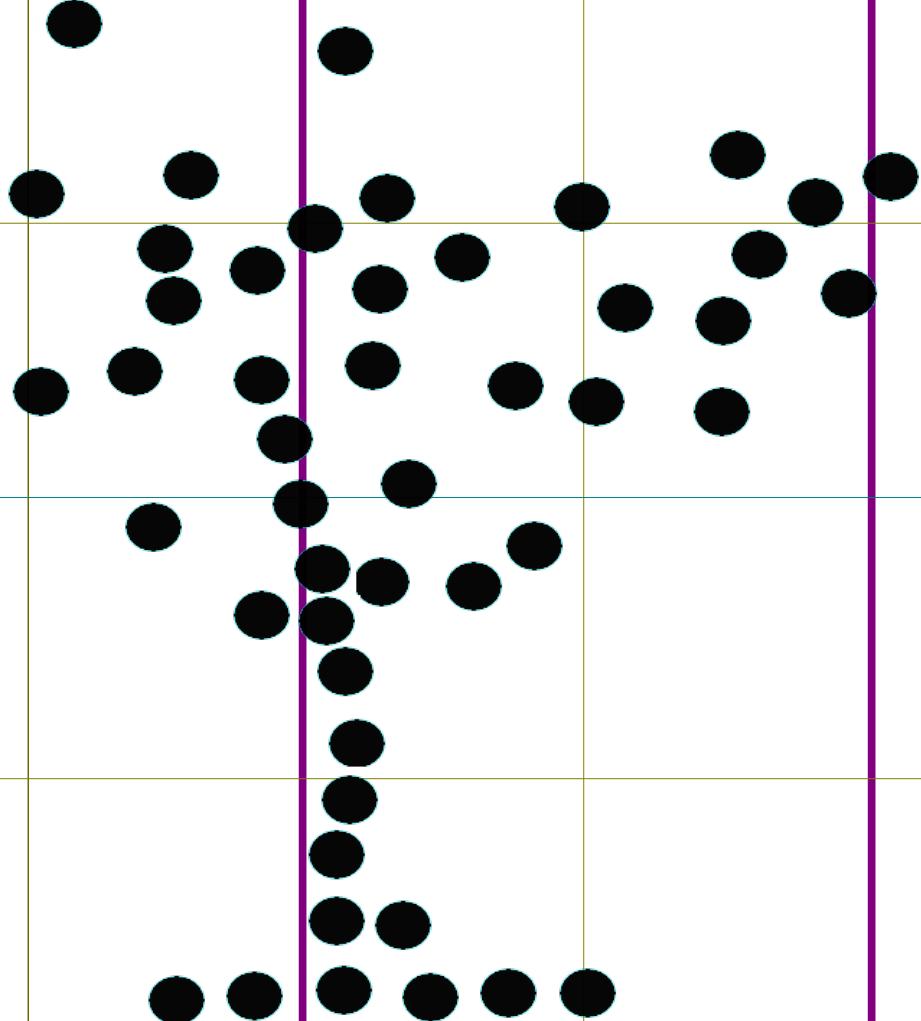


“Pillars”

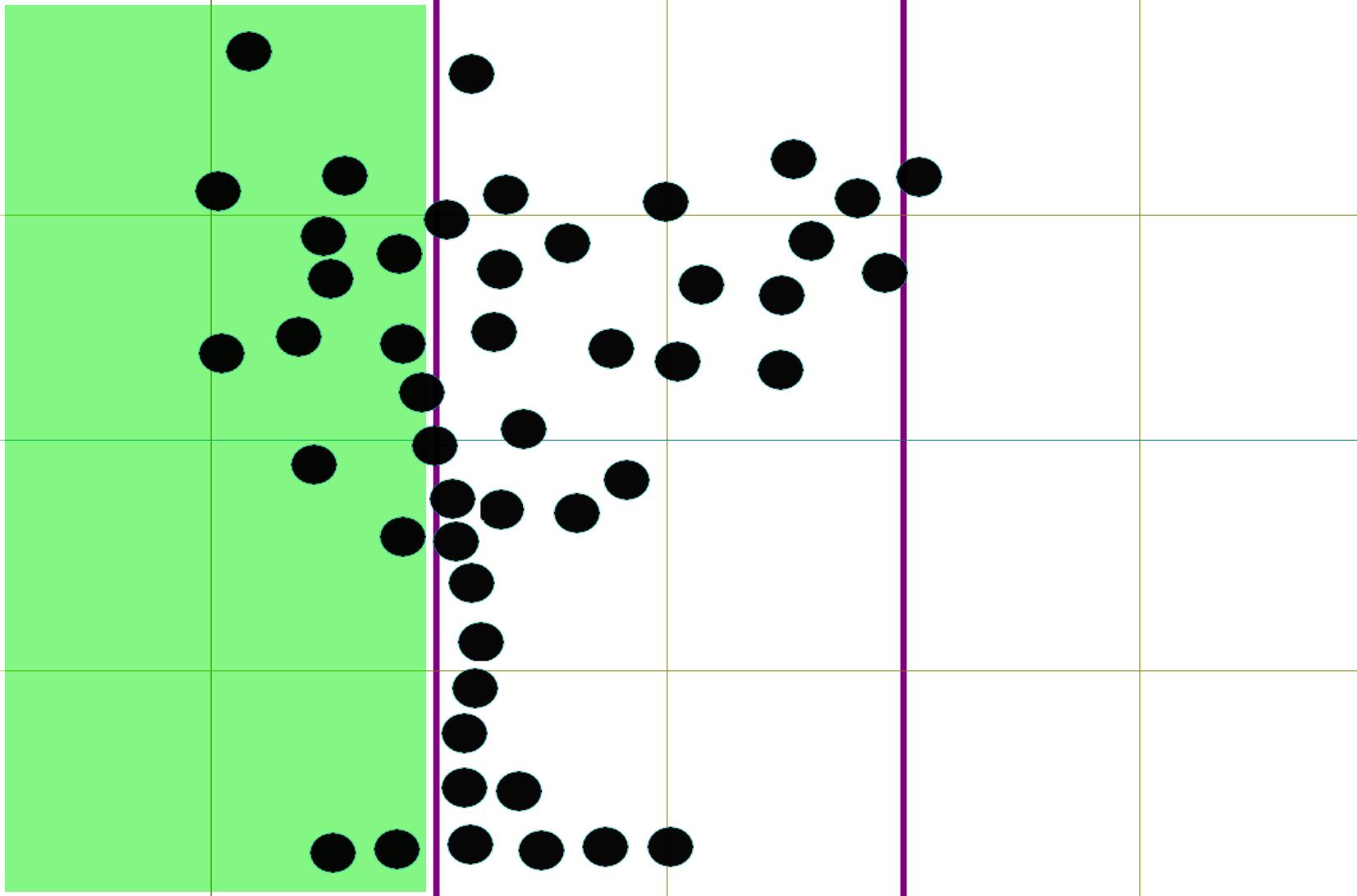
“Blocks”

Voxels

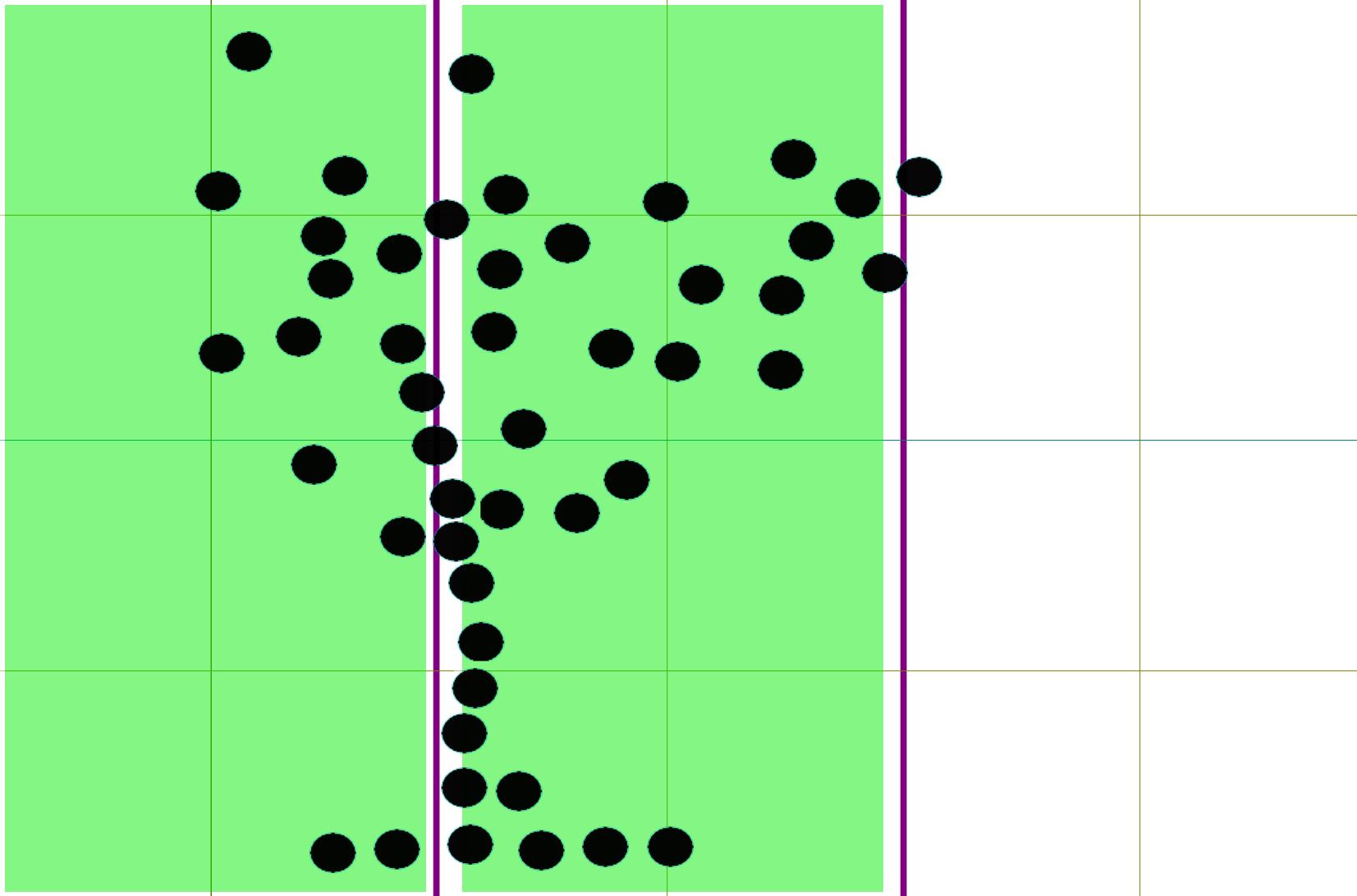
# Loop over pillars



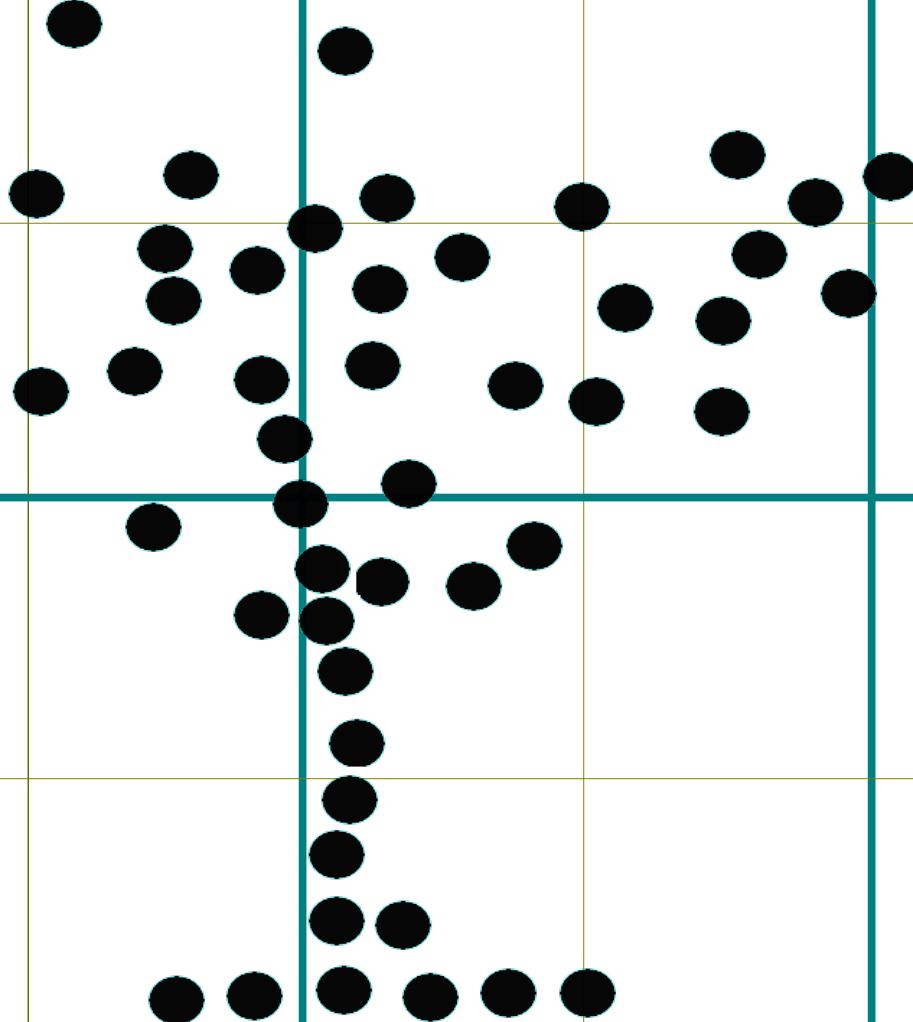
## Loop over pillars



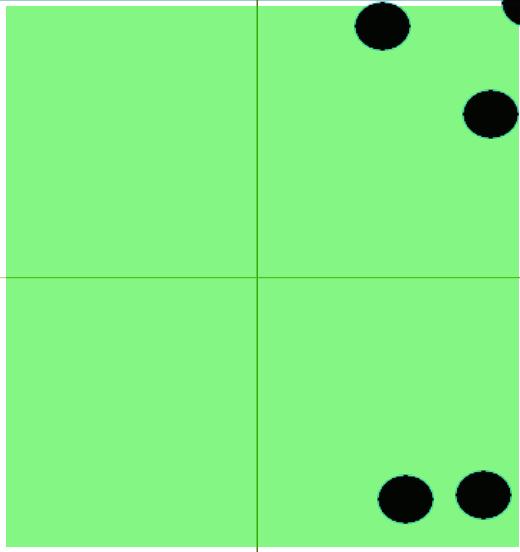
## Loop over pillars



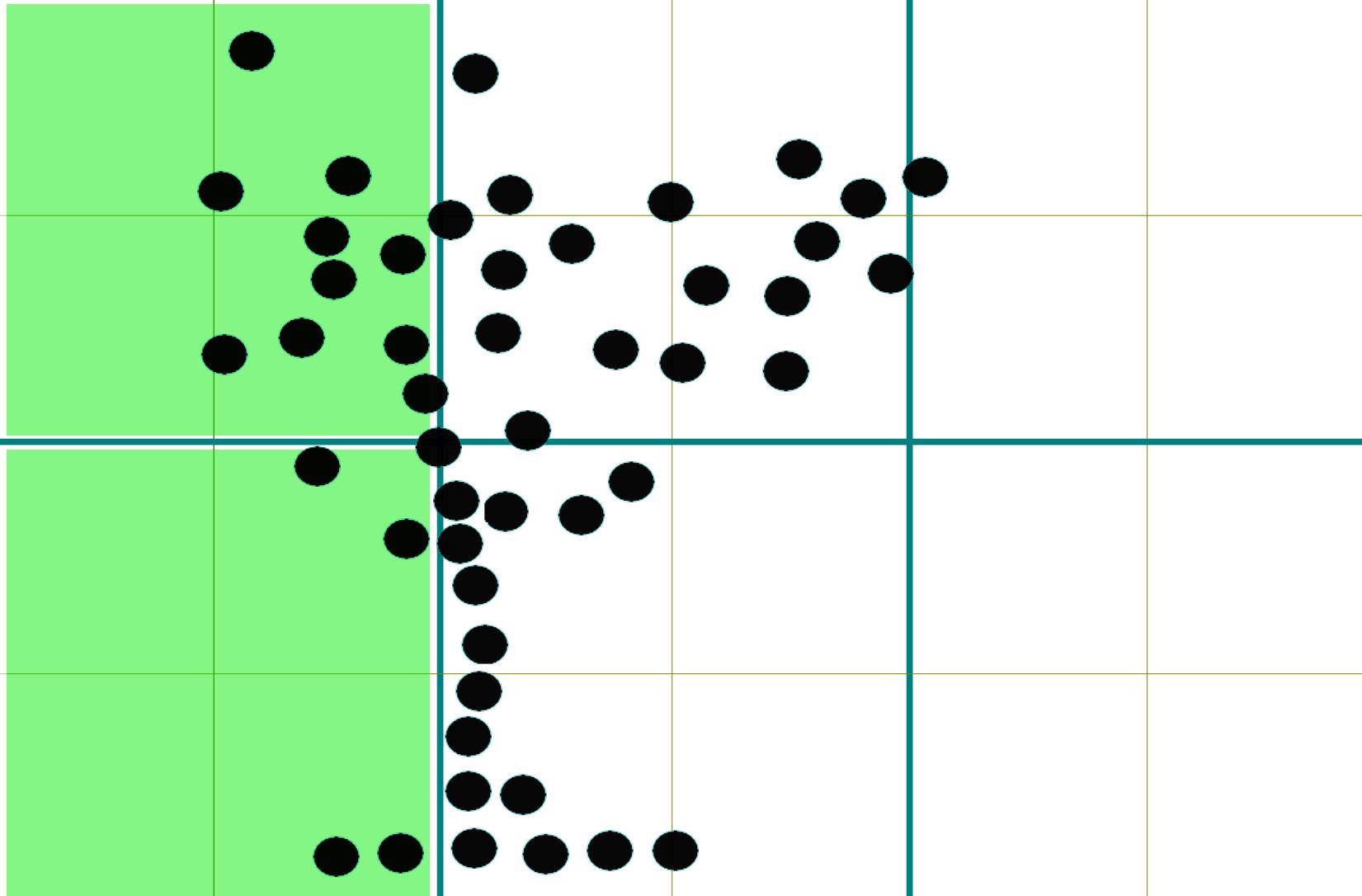
**Loop over blocks**



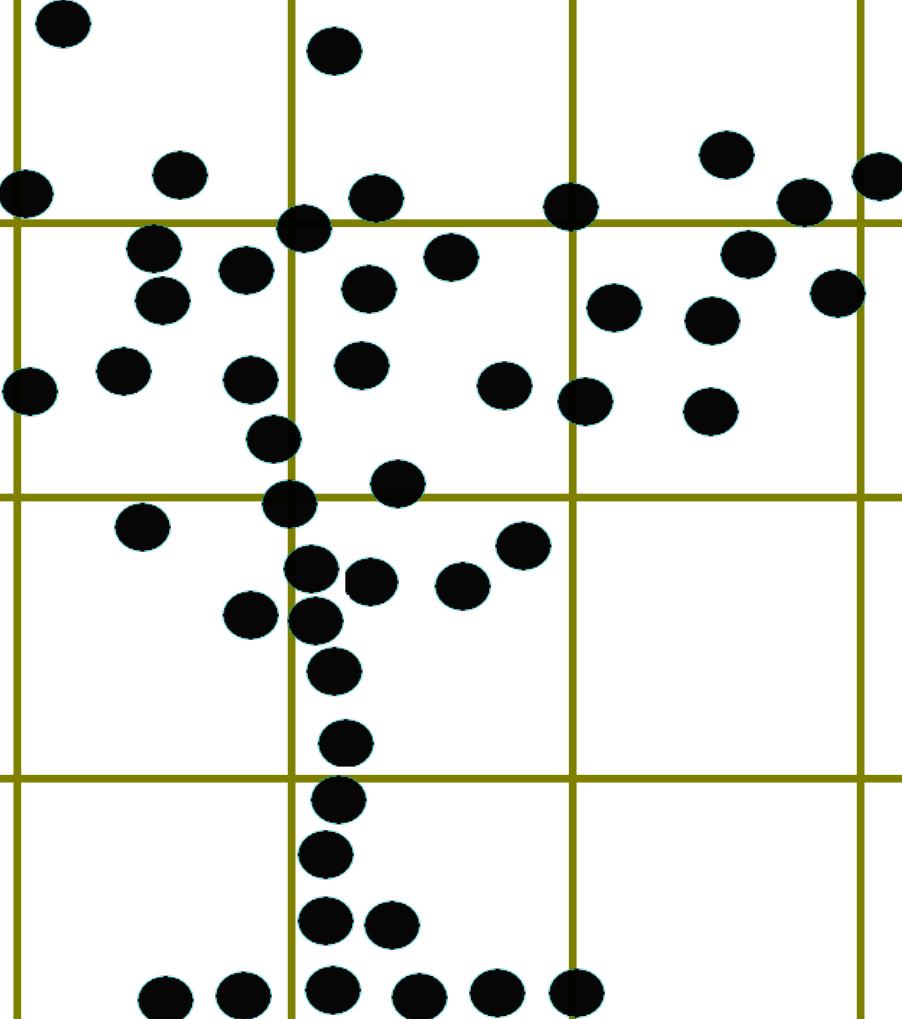
## Loop over blocks



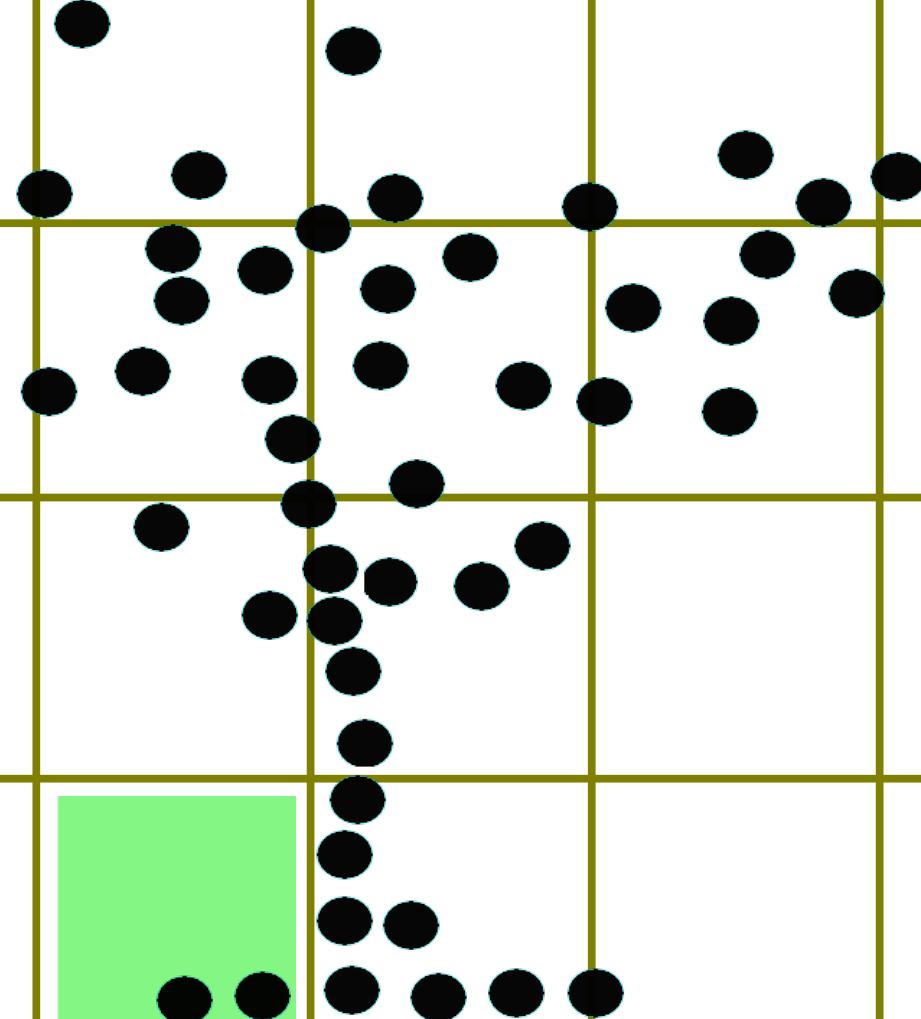
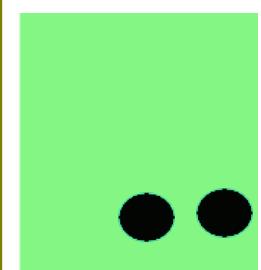
## Loop over blocks



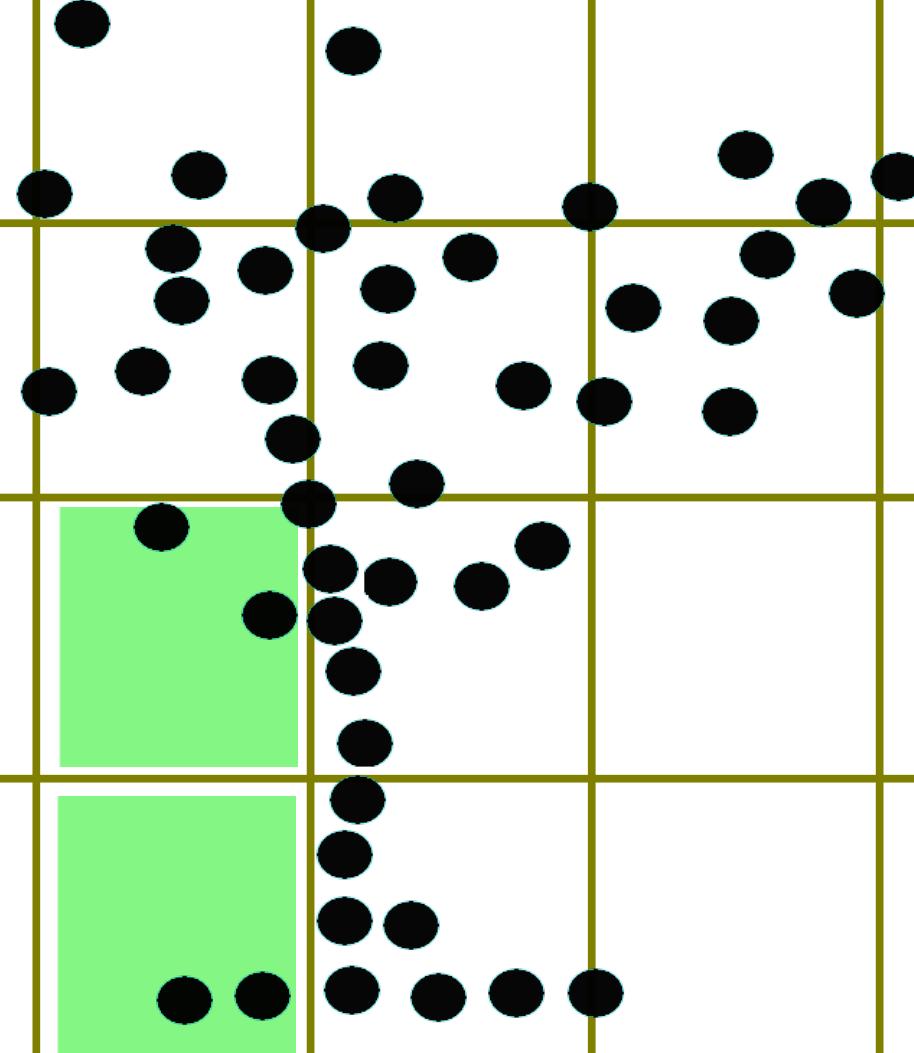
**Loop over voxels**



**Loop over voxels**

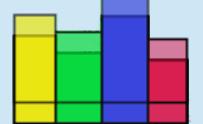


**Loop over voxels**





Average distribution for  
Assigning final label



Each “dot” is  
a voxel

## Label Assignment

Green box is one of  
the finest regions

