Object Detection Using Given Key Words

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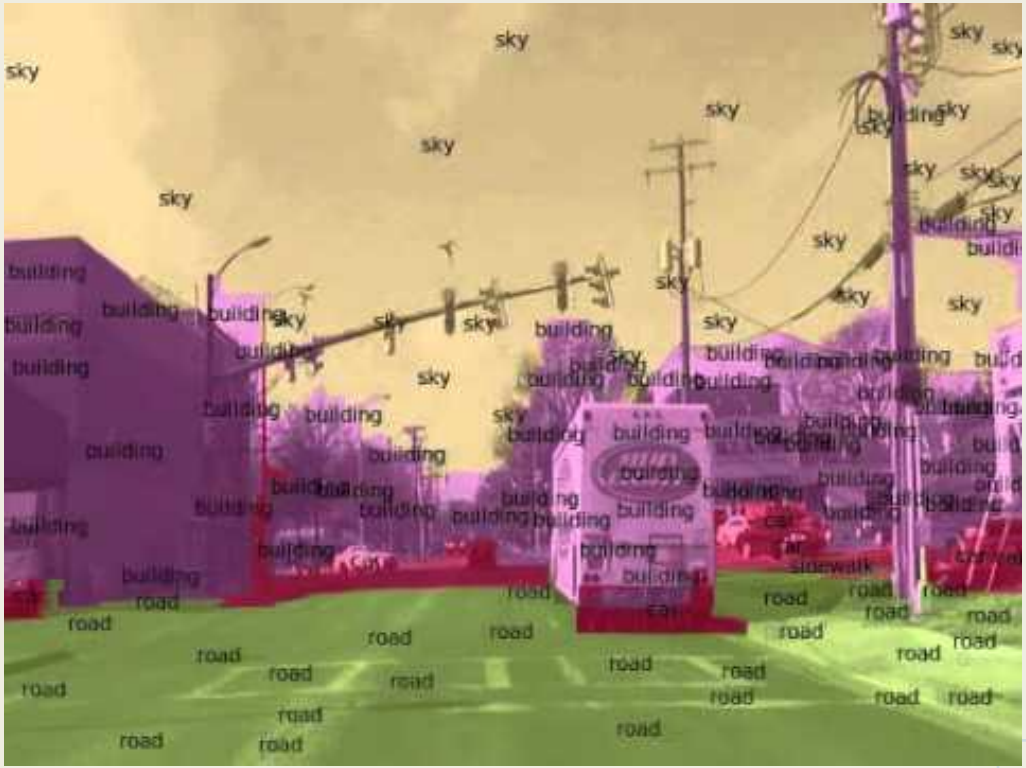
Real-Time Scene Parsing



Problem Statement

Original motivation:

- Necessary step for performing more complex tasks (i.e. robots grasping objects, etc.).
- Applications such as real-time scene parsing.

Given an image with a label for each pixel:

- Train a classifier to predict label for each pixel.
- User inputs a keyword and pixels with the corresponding label are highlighted.
- Using the model proposed by LeCun, *et al.*

Conventional Approaches

- Histogram-based methods
  - Histogram is computed from all the pixels in the image.
  - Peaks and valleys in the histogram are used to locate the clusters in the image.
  - Use color or intensity as measure.

Conventional Approaches

- Clustering methods
  - Use K-means algorithm to partition image into K clusters.
  - Assign each pixel in the image to the cluster that minimizes the distance between the pixel and cluster center.
  - Distance (either L2 or L1 norm) typically based on pixel color, intensity, texture, and location.

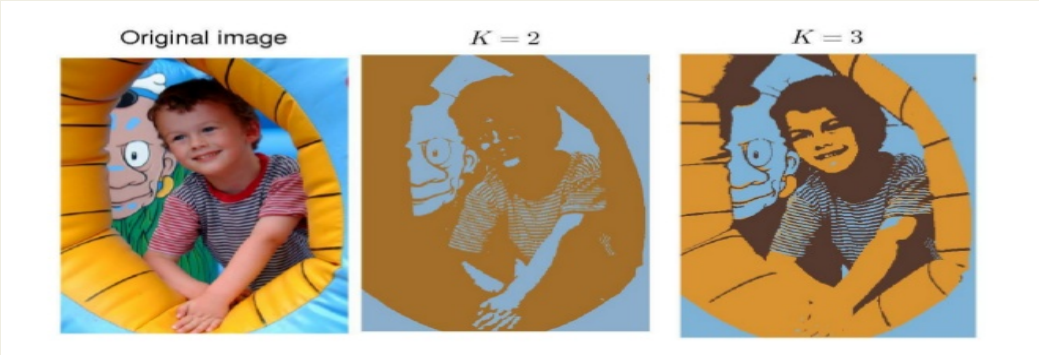
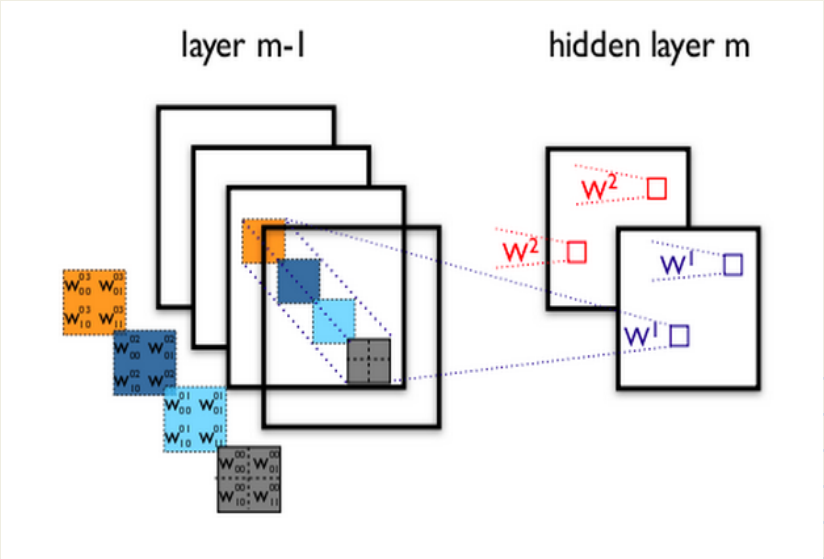


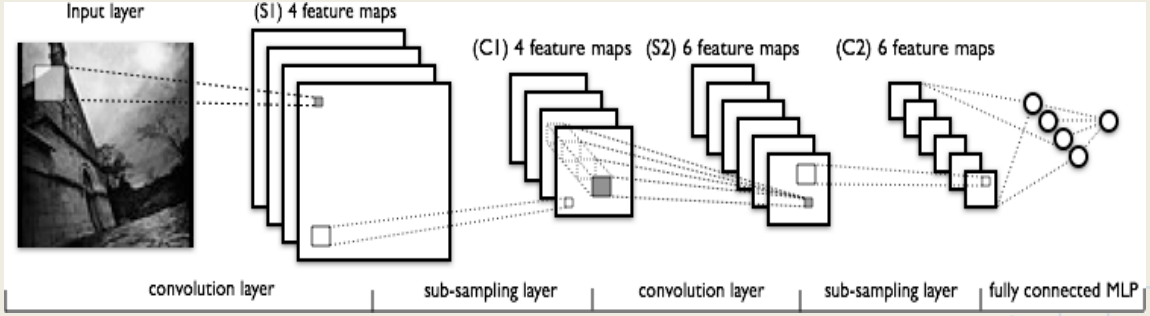
Image Segmentation Using Deep Learning

- Supervised learning model.
- Pixel label classification using CNNs.
- Feeding multiple scales of images into the CNN to obtain scale-invariant features.
- CNN filter layers perform feature extraction.
- Use logistic regression or MLP for classification based on accumulated features.

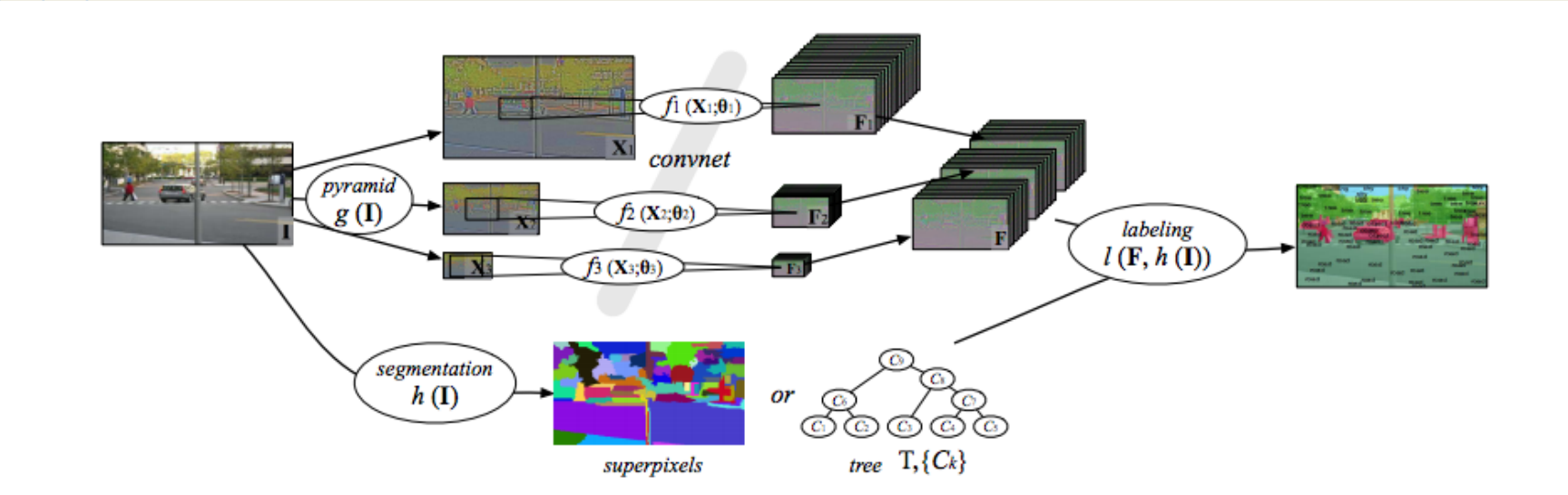


Implementation Details

- Preprocessing: Convert to YUV, zero-mean and unit variance.
- Sequence of CNN filters followed by max-pooling layers are used to compute feature maps for an image.
- Concatenate feature maps.
- Feed feature vector for each pixel into softmax function.
- 9 labels: sky, tree, road, grass, water, building, mountain, foreground objects, unknown.



Multiscale Convolutional Neural Network



- Construct a pyramid of input images by downsampling original image (achieve scale invariance).
- Training over half a million parameters on GPU.

Results

Models	**Validation Error**	**Test Error**
Single-scale model	30.785%	32.026%
Multi-scale model	28.561%	30.527%
LeCun *et al.* 2012 (single-scale)	-	34%
LeCun *et al.* 2012 (multi-scale)	-	22.2%

Results (Original Image)

Results (Single-Scale CNN)

Results (Original Labels)

Results (Original Image)

Results (Single-Scale CNN)

Results (Original Labels)

Results (Original Image)

Results (Single-Scale CNN)

Future Work

- More background datasets.
- Natural language processing.
- Speech recognition.
- Superpixels.
- Upsampling using interpolation.