Edge Detection and Simple Semantic Segmentation

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Edge Detection and (simple) Semantic Segmentation as examples of low-level vision.
Why do we care about edges?

• A Line Drawing is simple representation of the image (far fewer bits than a normal image).
• They are often sufficient to interpret the entire image (caveats).
• The Line Drawing is composed of edges – an “edge map”.

What Does the Line Drawing Represent?

- They represent the boundaries of objects.
- They represent interior edges of objects.
- They represent texture edges.
- Mooney images – a caveat: edges alone are not sufficient. Black and white helps.
But how can we find edges?

- Edge detection applies local operations (filtering) to images in order to detect edges. Local – low-level vision.
- Typically look at a local image patch – 3x3 pixels, or 8 x8 pixels – and decide if there is an edge or not.
- This is binary classification task – machine learning/statistics.

\[
\begin{bmatrix}
120 & 118 & 110 & 115 & 116 & 120 \\
115 & 21 & 20 & 16 & 19 & 121 \\
112 & 19 & 17 & 18 & 20 & 117 \\
119 & 118 & 121 & 117 & 116 & 112 \\
\end{bmatrix}
\]
(a) Intensity matrix of an image

(b) Image of the matrix (150x100)
Typically edges occur at places where the intensity gradient changes.

- Idealized edges: Images $I(x)$. Derivative of Image $dI(x)/dx$
But Images are much more complex than this simple picture

• The intensity gradient can be very small at the boundaries of an object. This is surprising to humans since we use context to interpret images. This context can be non-local or high-level (e.g., recognition), later in this course.

• Fox. Local edges – threshold gradient. Steeple Image (ambiguous)
How to Perform Edge Detection.

• Classic approach – define an ideal model of an edge and obtain an optimal edge detector (Canny 1986).

• Treat Edge Detection as a statistical machine learning problem. Requires a dataset with ground truth (positions of edge specified). (Konishi, Yuille, Coughlan, Zhu 1999).
Figure 5. Upper Panels: the data images. Lower Panels: the groundtruth edge maps.
Statistical Edge Detection

• Konishi, Yuille, Coughlan, Zhu. CVPR. 1999.
• Learn conditional probability distributions of image features conditioned on whether there is an edge or not (on-edge, off-edge).
• Use log-likelihood ratio test to detect edges.
Different Datasets.

• Hard (Sowerby) and Easy (S. Florida) Datasets.

Sowerby consists of outdoor images. Much texture and vegetation.

South Florida consist of indoor images. Very little texture.
Semantic Segmentation: What else can you classify locally?

• What about “sky”, “vegetation”, “water”? 

• These are roughly homogeneous. E.g., all parts of sky are similar. 

• Colour and Texture.
Label Regions Sowerby

• Konishi and Yuille. CVPR. 2018.
• Output examples.
Label Regions: San Francisco