CMPSC382
Lecture 18: Convolution

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Joe’s code has 20 bugs. If Joe fixes 2 bugs per hour for 8 hours, how many bugs does Joe’s code have now?
Last Time

• Image scaling
  – Theory
  – Bad code demo
• Content-Aware Image Scaling video
• Preview of convolution
Convolution

• “A mathematical operation on two functions, $f$ and $g$, producing a first function that outputs the area overlap between the two functions as a function of the amount that one of the original functions is translated.”
  – Show function $f$ on a graph.
  – Shift function $g$ across the x-dimension of the graph.
  – Output the percentage of the overlap area of $f$ and $g$ for each position that $g$ takes.
Convolution in Image Processing

\[ E' = w_0A + w_1B + w_2C + w_3D + w_4E + w_5F + w_6G + w_7H + w_8I \]
Identity

- No change made to the image

\[
\begin{array}{ccc}
0 & 0 & 0 \\
0 & 1 & 0 \\
0 & 0 & 0 \\
\end{array}
\]
Average (Smoothing Filter)

• Set pixel to the average of all colors in the neighborhood
• Smoothes out areas of sharp change

\[
\begin{array}{ccc}
\frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\
\frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\
\frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\
\end{array}
\]
Sharpen (High Pass Filter)

- Enhances the difference between neighboring pixels
- The greater the difference, the more change in the current pixel

\[

g(x_0) = \begin{bmatrix}
0 & -2/3 & 0 \\
-2/3 & 11/3 & -2/3 \\
0 & -2/3 & 0 \\
\end{bmatrix}
\]
Blur (Low Pass Filter)

• Softens significant color changes in image
• Creates intermediate colors

\[
\begin{array}{ccc}
\frac{1}{16} & \frac{2}{16} & \frac{1}{16} \\
\frac{2}{16} & \frac{4}{16} & \frac{2}{16} \\
\frac{1}{16} & \frac{2}{16} & \frac{1}{16}
\end{array}
\]
Any Questions?