CS4670: Computer Vision
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Image Interpolation

Last time:
This image is too big to fit on the screen. How can we generate a half-sized version?
Upsampling

• This image is too small for this screen: 📷
• How can we make it 10 times as big?
• Simplest approach:
  repeat each row
  and column 10 times
• (“Nearest neighbor interpolation”)

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Image interpolation

Recall how a digital image is formed

\[ F[x, y] = \text{quantize}\{f(xd, yd)\} \]

• It is a discrete point-sampling of a continuous function
• If we could somehow reconstruct the original function, any new image could be generated, at any resolution and scale

Adapted from: S. Seitz
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Adapted from: S. Seitz

• What if we don’t know \( f \)?
  - Guess an approximation: \( \tilde{f} \)
  - Can be done in a principled way: filtering
  - Convert \( F \) to a continuous function:
    \[ f_F(x) = F(x_d) \text{ when } x_d \text{ is an integer, } 0 \text{ otherwise} \]
  - Reconstruct by convolution with a reconstruction filter, \( h \)
    \[ \tilde{f} = h * f_F \]
Image interpolation

- **sinc(x)**: "Ideal" reconstruction
- **II(x)**: Nearest-neighbor interpolation
- **Λ(x)**: Linear interpolation
- **gauss(x)**: Gaussian reconstruction

Source: B. Curless

Reconstruction filters

- What does the 2D version of this hat function look like?

\[ h(x) \] performs linear interpolation
\[ h(x, y) \] (tent function) performs bilinear interpolation

Often implemented without cross-correlation

Better filters give better resampled images
- **Bicubic** is common choice

Cubic reconstruction filter
Image interpolation

Original image: x 10

Nearest-neighbor interpolation  Bilinear interpolation  Bicubic interpolation

Also used for resampling
Raster to Vector Graphics

Depixelating Pixel Art
Questions?