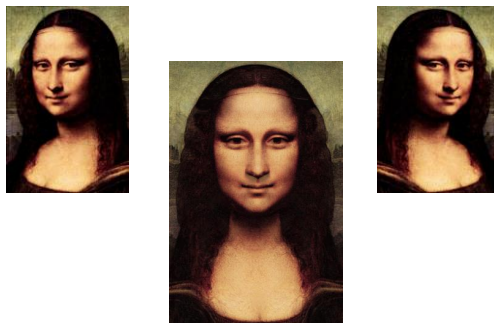


CS4670: Computer Vision

Noah Snavely

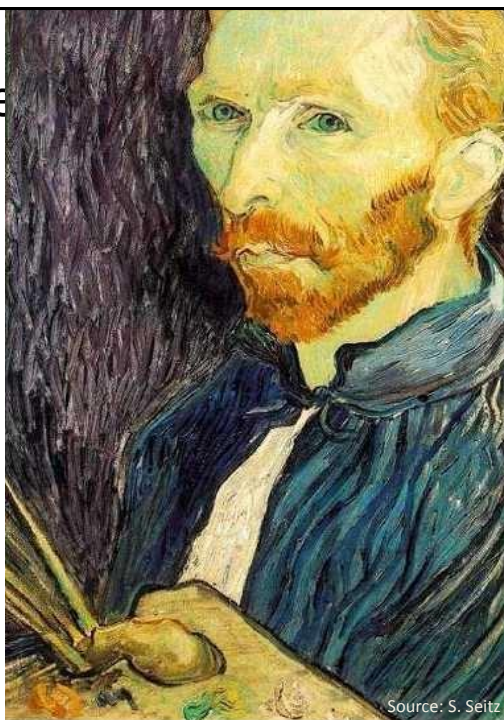
Image Interpolation



Image

Last time:

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



Upsampling


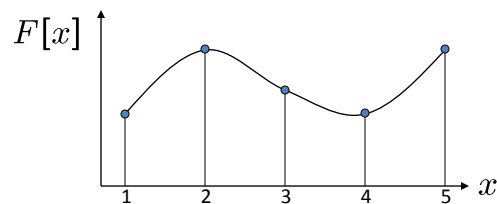
- This image is too small for this screen: 
- How can we make it 10 times as big?
- Simplest approach:
repeat each row
and column 10 times
- (“Nearest neighbor interpolation”)



Image interpolation



$d = 1$ in this example

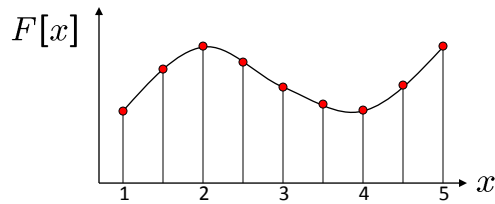
Recall how a digital image is formed

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

- 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

Image interpolation



$d = 1$ in this example

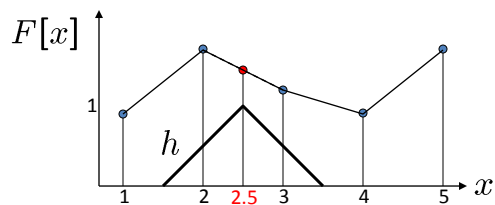
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Adapted from: S. Seitz

Image interpolation



$d = 1$ in this example

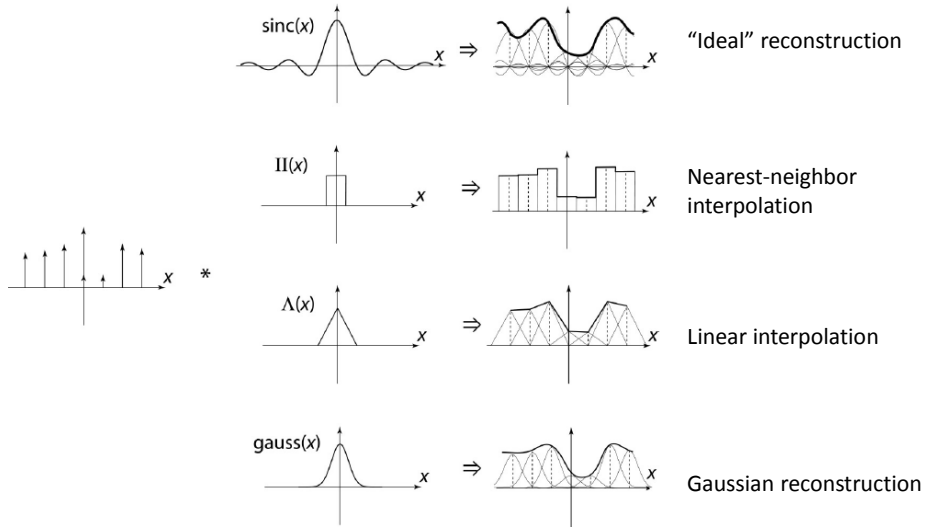
- What if we don't know f ?
 - Guess an approximation: \tilde{f}
 - Can be done in a principled way: filtering
 - Convert F to a continuous function:

$$f_F(x) = F\left(\frac{x}{d}\right) \text{ when } \frac{x}{d} \text{ is an integer, } 0 \text{ otherwise}$$
 - Reconstruct by convolution with a *reconstruction filter*, h

$$\tilde{f} = h * f_F$$

Adapted from: S. Seitz

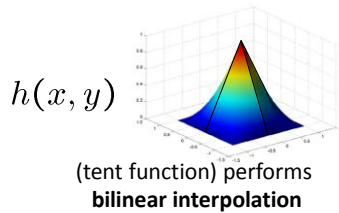
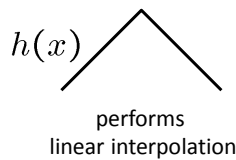
Image interpolation



Source: B. Curless

Reconstruction filters

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

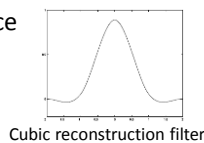


Often implemented without cross-correlation

- E.g., http://en.wikipedia.org/wiki/Bilinear_interpolation


Better filters give better resampled images

- **Bicubic** is common choice



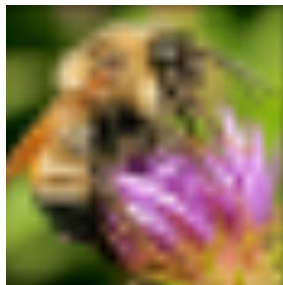
$$r(x) = \begin{cases} \frac{1}{6} [(12 - 9B - 6C)|x|^3 + (-18 + 12B + 6C)|x|^2 + (6 - 2B)] & |x| < 1 \\ \frac{1}{6} [(-B - 6C)|x|^3 + (6B + 30C)|x|^2 + (-12B - 48C)|x| + (8B + 24C)] & 1 \leq |x| < 2 \\ 0 & \text{otherwise} \end{cases}$$

Image interpolation

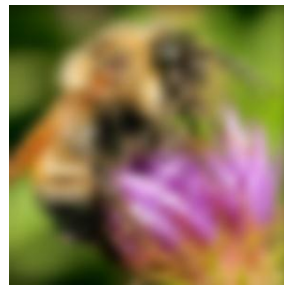
Original image:  x 10



Nearest-neighbor interpolation



Bilinear interpolation



Bicubic interpolation

Image interpolation

Also used for *resampling*



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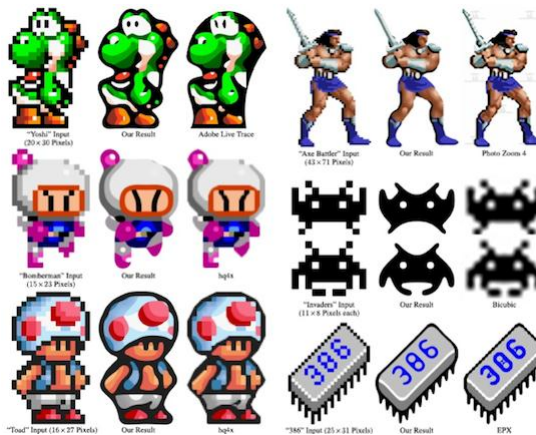
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- Easier to use
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Questions?