Reconstruction Example (from students)

... gives what?

assume that it was properly sampled
⇒ orig signal has sin waves only greater than 2 samples

is impossible (this F was cut out)

only answer = ...

Reconstruction

... ideally low-pass filter
⇒ can't really implement LPF

interpolation → filtering
- linear interpolation ⇒ tent filter
  show convolution gives same
- nearest neighbor interpolation ⇒ box filter
  show convolution gives the same
- interpolating cubic

non-interpolating kernels
scaling issues
Sampling

Prefiltering - convolve with LPF

- not really an LPF
- hard to approximate ringing

Gaussian $\longrightarrow$ Binomial

Resampling

What we really do often
- change number of samples (resize)
- move the samples around (warp - later)

resample to half size:

Steps:
- reconstruct
- sample

incoherent

sample

point sample

\( f \ast (r * s) \)

- can put these together into 1

Since we only need to sample at certain places
reconstruction might be easy (half samples)

since the signal might already be sufficiently band-passed,
sampling might be easy

only 1 filter is really active
- apply 2 ideal LPF $\Rightarrow$ applying lowest one
Scale down by half

- Pitch sampling kernel LPF with cutoff > 2 cycles
- Binomial Approx: \( \frac{1}{16} [1 4 6 4 1] \)

... still just need some points...
- Apply pre-filter everywhere fast because uniform
- Only pre-filter at samples fast because less work

Double

... already bandpassed...
- \( \text{if } F_s < 2F \) just need reconstruction

Scale down by 1.5

- Need some sampling filter
  \( \frac{1}{8} 1 2 1 \) might be too much
  \( 0 1 0 \) too little,
  take halfway?
  \( \frac{1}{8} \frac{3}{4} \frac{1}{8} \)
- Need to reconstruct?
  Not really - just evaluate in continuous case
Intuitions on Filter Kernels...

narrower box = wider sinc
extreme & spike = constant

problems of Sync
- infinite extent
- negative values $\rightarrow$ ringing
  - hard to sample

approximations $\rightarrow$ Bunch of filters in the book is 4.3

Continuous $\rightarrow$ discrete

- box
- tent (Bartlett)
- gaussian (still infinite)
- binomial / B-Spline
  - convolutions of box
  - interpolating cubic

Wide enough to cover
Into 2D!

Little Square Model (for intuition, it's wrong)

old pixels or new pixels

Everything from 1D still works
convolutions hard to draw on board

Details of convolution
- for infinite extents
  makes signal bigger or just forget new shift

- dealing w/ boundaries
  0 pad / edge replication
  reflection
  normalization
- 0 centering

Separable Filters

Qualitative Convolutions
LPF
HPF
Shift
Shadow