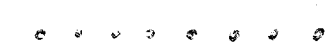
# Notes for 9/19/2006

## Reconstruction Example (from students)



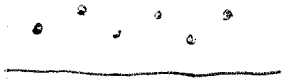
gives what?

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

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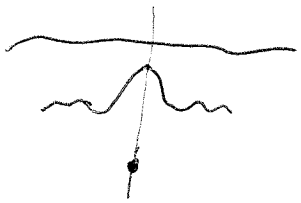
Sampling

Prefiltering - convolve w/ LPF

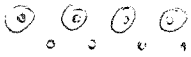


- not really an LPF
  hard to approximate
  ringing
  Gaussian → Binomial (skip to p4)

## Resampling

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

resample to half size:



steps: reconstruct $* r$ ← ~~sampling~~ reconstruct kernel
sample $* s$ ← sampling kernel
point sample

$f * r * s$ ← can put these together into 1

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

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

only 1 filter is really active
- apply 2 ideal LPF ⇒ applying lowest one

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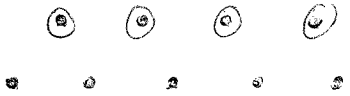
(3)

Scale down by half - ~~no need~~



pick sampling kernel LPF w/ cutoff > 2 cycles

Binomial Approx: $\frac{1}{4}[1\ 2\ 1]$

$\frac{1}{16}[1\ 4\ 6\ 4\ 1]$

still just need some points

(1) apply pre-filter everywhere ← fast because uniform

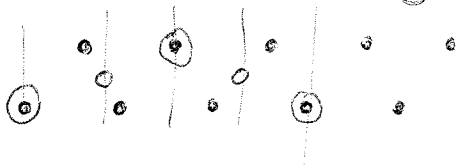
(2) only pre-filter at samples ← fast because less work

Double

already bandpassed (if < F, < 2F)

just need reconstruct ∧

Scale Down by 1.5



- need some sampling filter

$\frac{1}{4}$ 1 2 1 might be too much

~~1~~ 0 1 0 too little,

take halfway ?

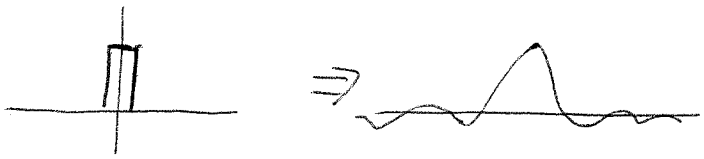
$\frac{1}{8}\ \frac{3}{4}\ \frac{1}{8}$

- need to reconstruct (?)

not really - just evaluate in continuous case

(4)

# Intuitions on Filter Kernels ...

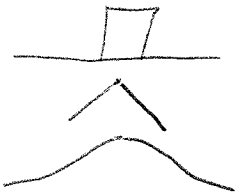


narrower box = wider sinc

extreme: spike = constant

problems w/ Sync
- infinite extent
- negative values → ringing
- hard to sample

approximators → Bunch of filters in the book ≈ 4.3



box

tent (bartlett)

gaussian (still infinite)

binomial / B-Spline

convolutions of box

interpolating cubic

continuous

discrete

$\frac{1}{2}$ 1 1

$\frac{1}{4}$ 1 2 1

$\frac{1}{8}$ 1 3 3 1

$\frac{1}{16}$ 1 4 6 4 1

:

Wide enough to cover

(5) Into 2D!

Little Square Model (for intuition, its wrong)


old pixels
new pixels

or


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

Details of convolution
- for infinite extents
  makes signal bigger ← or just forget new stuff
- dealing w/ boundaries
  0 pad / edge replication
  reflection
  normalization
- 0 centering

Separable Filters

QUALITATIVE CONVOLUTIONS
LPF
HPF
Shift
Shadow