Review of Signal Processing: Intuitions
Filters and Filter Quality
Resampling

Signal / Image \(\Rightarrow\) Frequency Domain
"High Frequencies"
Band Limits
Low Pass Filter \(\Leftrightarrow\) Blur
Samples = Spike Chain
Ideal / Real Reconstruction

Filter Properties:
Cutoff Frequency
- lower cutoff = wider filter
Width / Cutoff vs. Extent

\[ \text{cutoff} \quad \text{"about"} \quad \frac{1}{4} \text{ sample rate} \]
\[ \text{cutoff much lower than sample rate} \]
\[ \text{rather than getting height right,} \]
\[ \text{just normalize samples} \]
Some Filters

Sinc

Box

\[ \frac{1}{2} \]

easy!
no ringing!

Tent

easy
no ringing \( c(i) \)

B-Spline

always positive
blurs increasingly
Convolutions of unit box
Stops interpolating after 1

\[ \text{Ideal LPF Rings} \]

\[ \text{not as sharp as it should be} \]
\[ \text{extra high frequencies we don't want} \]

\[ \text{sinc}^2 \]

\[ \text{falls off too fast = blury} \]
\[ \text{still has lobes} \]

\[ \text{sinc}^n \]
Interpolating Filters -
ring (if > 1)

Cubic spline - catmull rom
much sharper
ringing

Mitchell Netravali
Blend B-Spline w/ CR
balance sharpness w/ ringing

Sometimes use wider filters to be conservative
Resampling

samples

reconstruct

sample

if the band limit is OK for sampling rate we're OK

if the band limit is not OK need to prefilter

filter width based on target samples - same sampling rate issues

Ideal Case: Lower filter dominates

this one lets through more - but it's already been cut out
Resampling in practice - we only evaluate convolution at samples

Sample filter kernel at appropriate places
renormalize so it adds to 1!

\[-2 \quad -1 \quad 0 \quad 1 \quad 2\] in data
\[-1 \quad 0 \quad 1 \quad 1\] in target

\[\frac{1}{2}\]

\[\wedge\] ← pick source, not target filter

In practice, up-sampling: use sharper filters