



University of British Columbia
CPSC 314 Computer Graphics
Jan-Apr 2010

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Antialiasing II

Week 11, Wed Mar 31

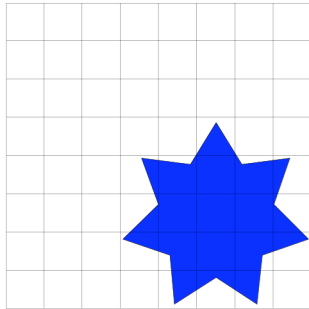
<http://www.ugrad.cs.ubc.ca/~cs314/Vjan2010>

News

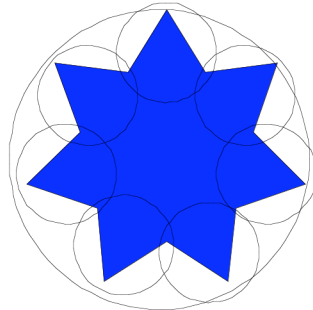
- P4 proposals due now
 - don't wait for feedback from me to start! you'll only hear from me if there's a problem
- typo on P4 writeup
 - it's worth 15% of grade not 18%

Review: Spatial Data Structures

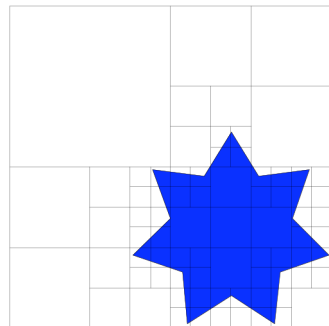
uniform grids



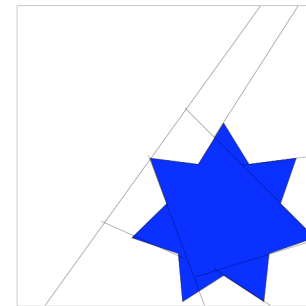
bounding volume hierarchies



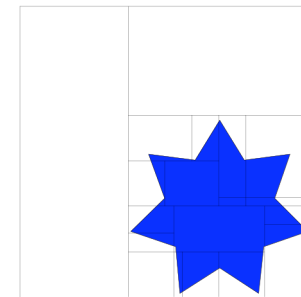
octrees



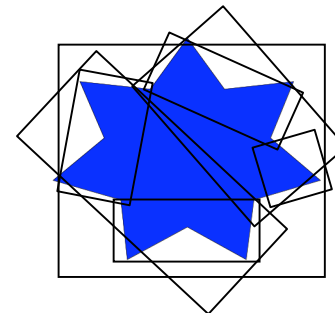
BSP trees



kd-trees



OBB trees

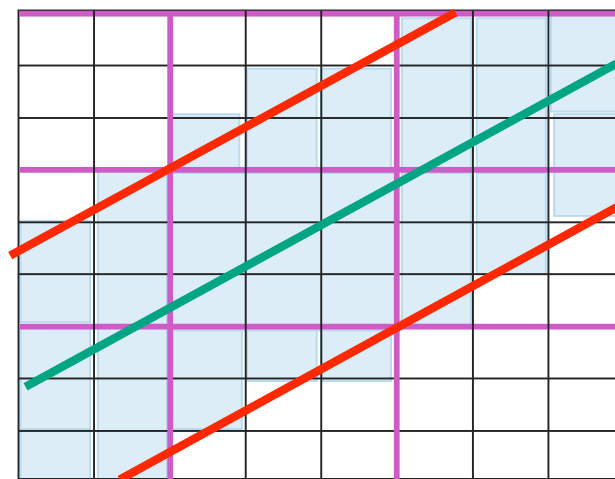
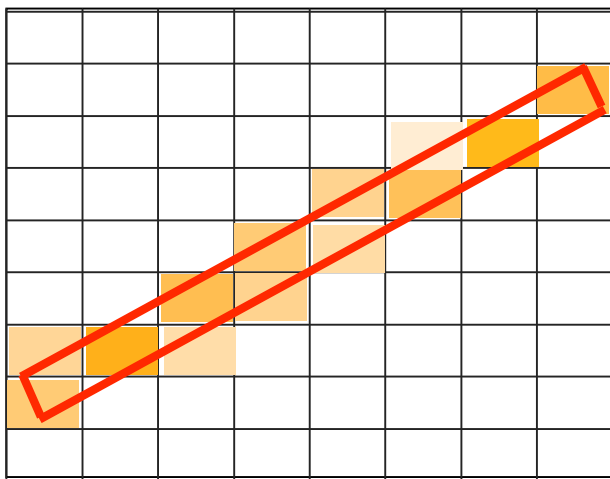


Review: Aliasing

- incorrect appearance of high frequencies as low frequencies
- to avoid: **antialiasing**
 - supersample
 - sample at higher frequency
 - low pass filtering
 - remove high frequency function parts
 - aka prefiltering, band-limiting

Review: Supersample and Average

- supersample: create image at higher resolution
 - e.g. 768x768 instead of 256x256
 - shade pixels wrt area covered by thick line/rectangle
- average across many pixels
 - e.g. 3x3 small pixel block to find value for 1 big pixel
 - rough approximation divides each pixel into a finer grid of pixels

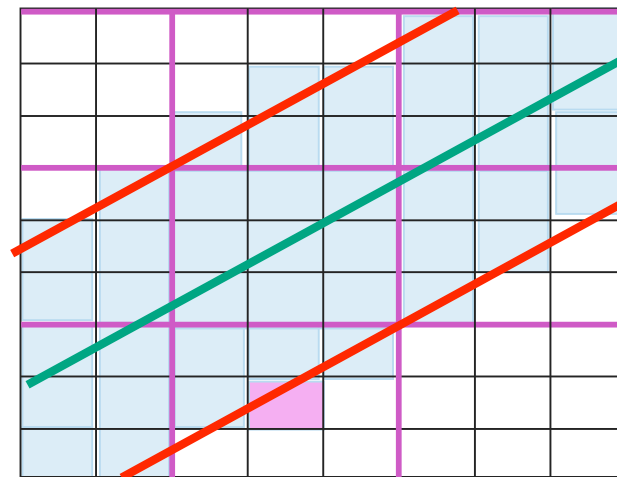
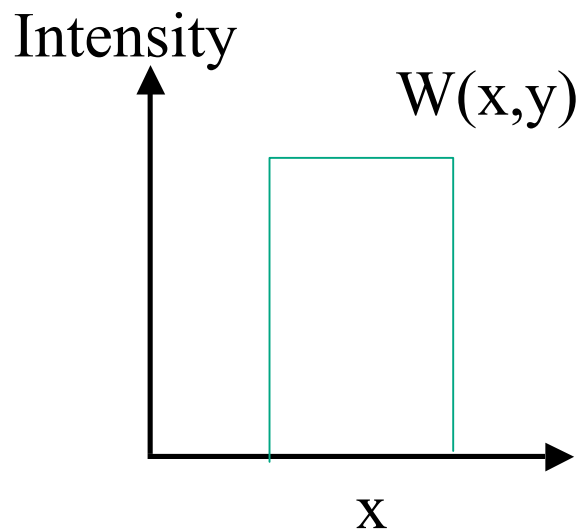


	5/9	9/9
	9/9	6/9
	4/9	0/9

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Supersample and Average

- supersample: jaggies less obvious, but still there
 - small pixel center check still misses information
 - unweighted area sampling
 - equal areas cause equal intensity, regardless of distance from pixel center to area
 - aka box filter

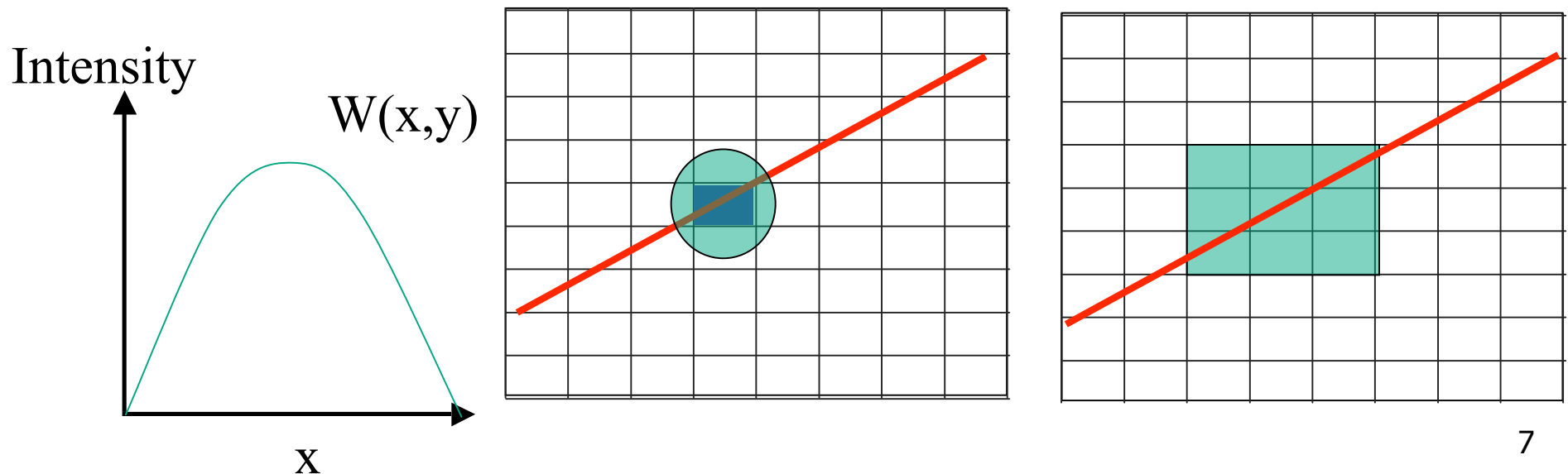


	5/9	9/9
	9/9	6/9
	4/9	0/9

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Weighted Area Sampling

- intuitively, pixel cut through the center should be more heavily weighted than one cut along corner
- weighting function, $W(x,y)$
 - specifies the contribution of primitive passing through the point (x, y) from pixel center
 - Gaussian filter (or approximation) commonly used



Sampling Errors

- some objects missed entirely, others poorly sampled
 - could try unweighted or weighted area sampling
 - but how can we be sure we show everything?
- need to think about entire class of solutions!
 - brief taste of signal processing (Chap 4 FCG)

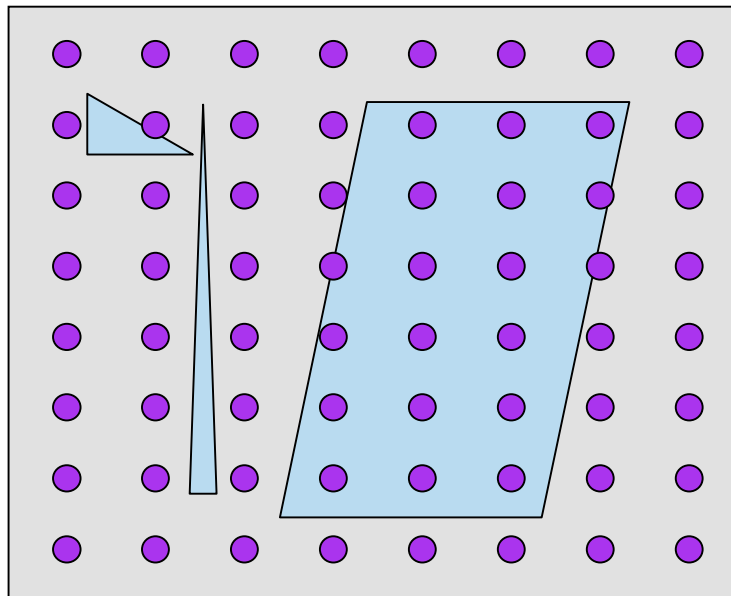
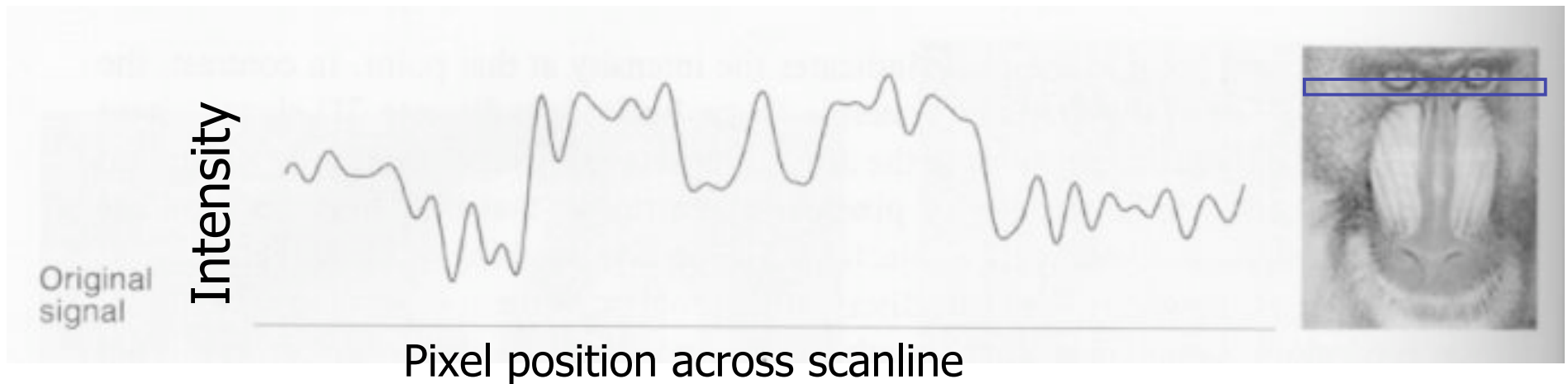


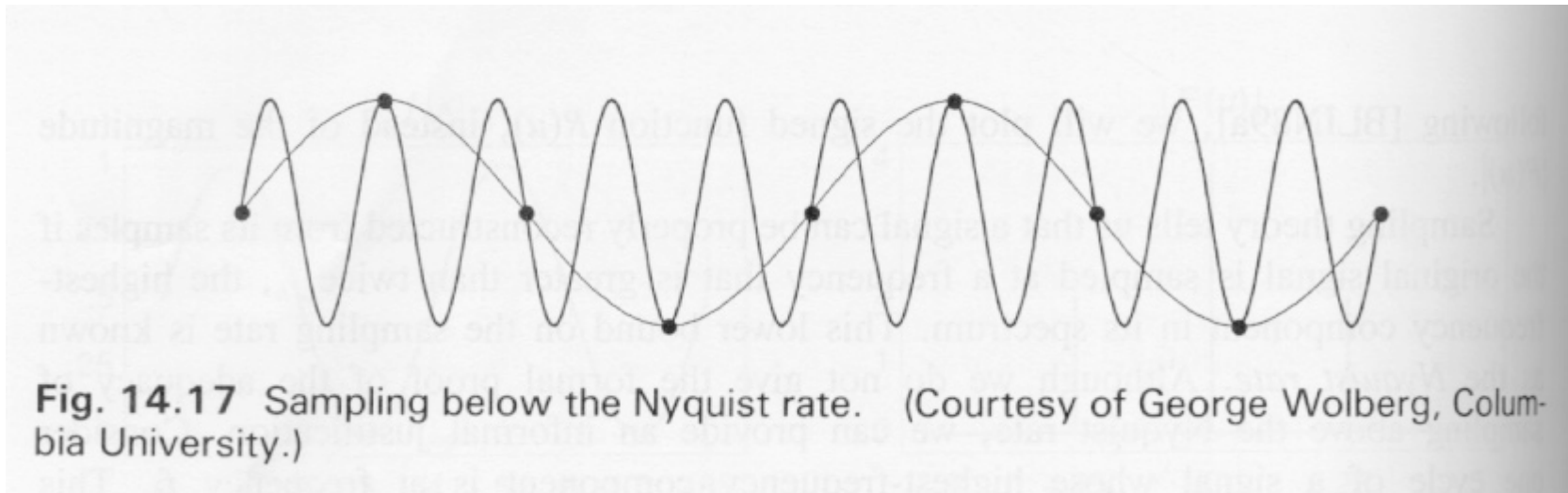
Image As Signal

- image as spatial signal
- 2D raster image
 - discrete sampling of 2D spatial signal
- 1D slice of raster image
 - discrete sampling of 1D spatial signal



Sampling Frequency

- if don't sample often enough, resulting signal misinterpreted as lower-frequency one
 - we call this **aliasing**



Sampling Theorem

continuous signal can be completely recovered from its samples

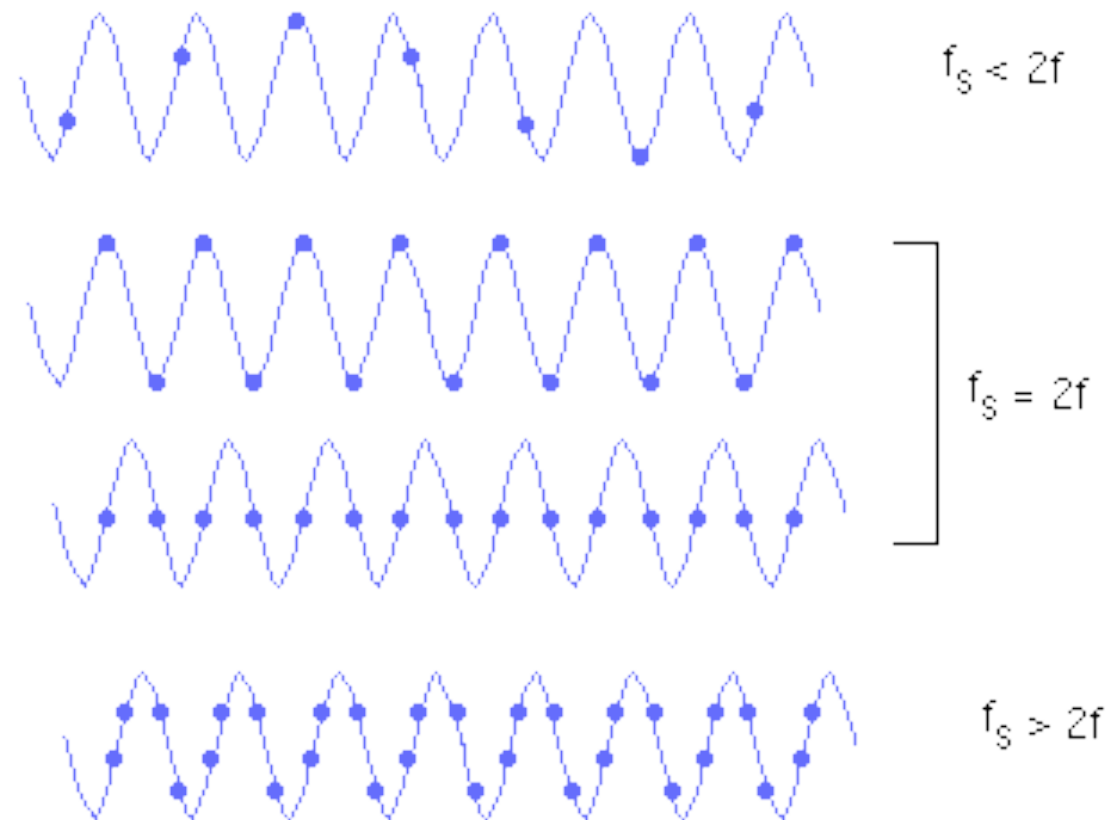
iff

sampling rate greater than twice maximum frequency present in signal

- Claude Shannon

Nyquist Rate

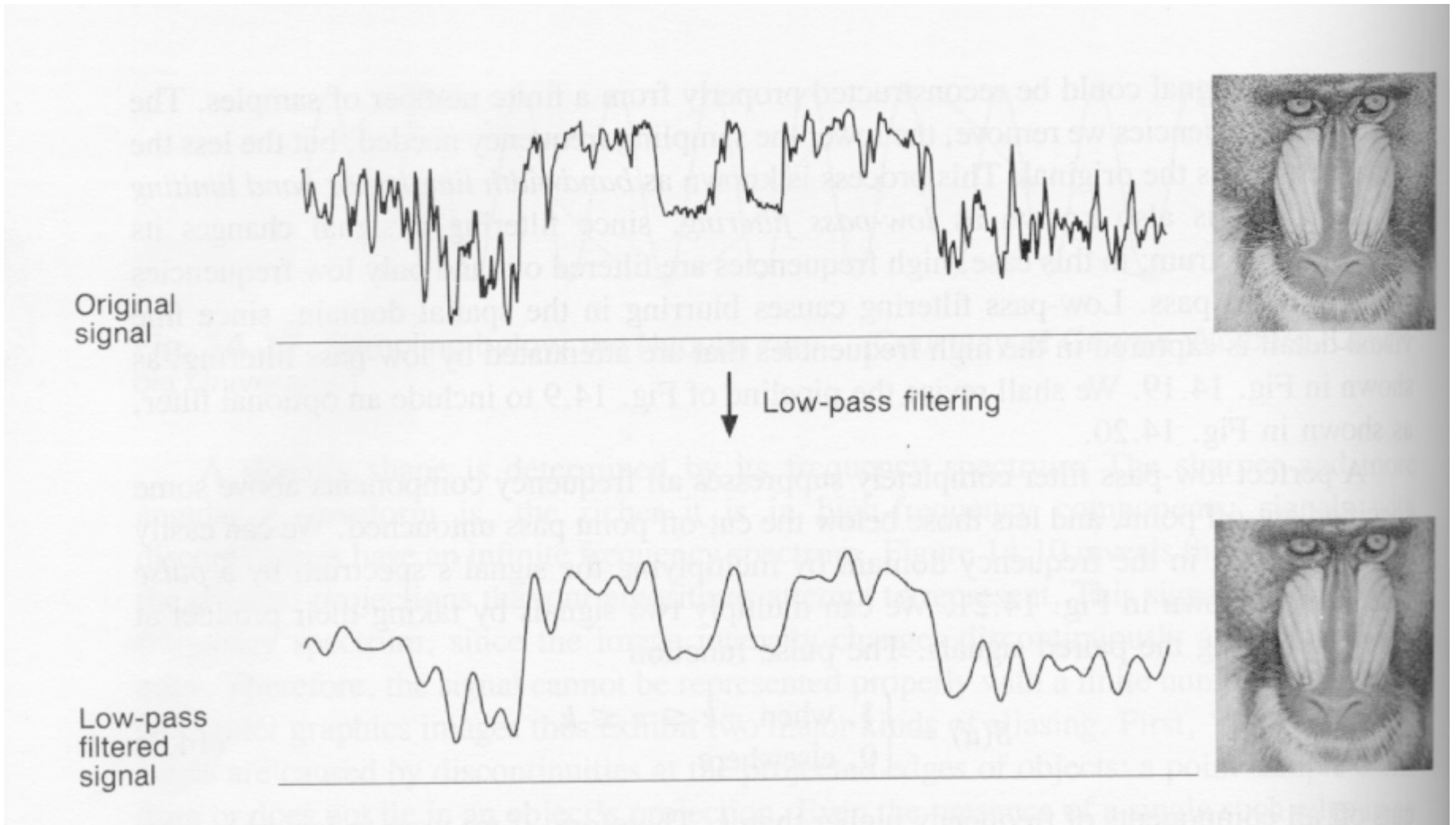
- lower bound on sampling rate
 - twice the highest frequency component in the image's spectrum



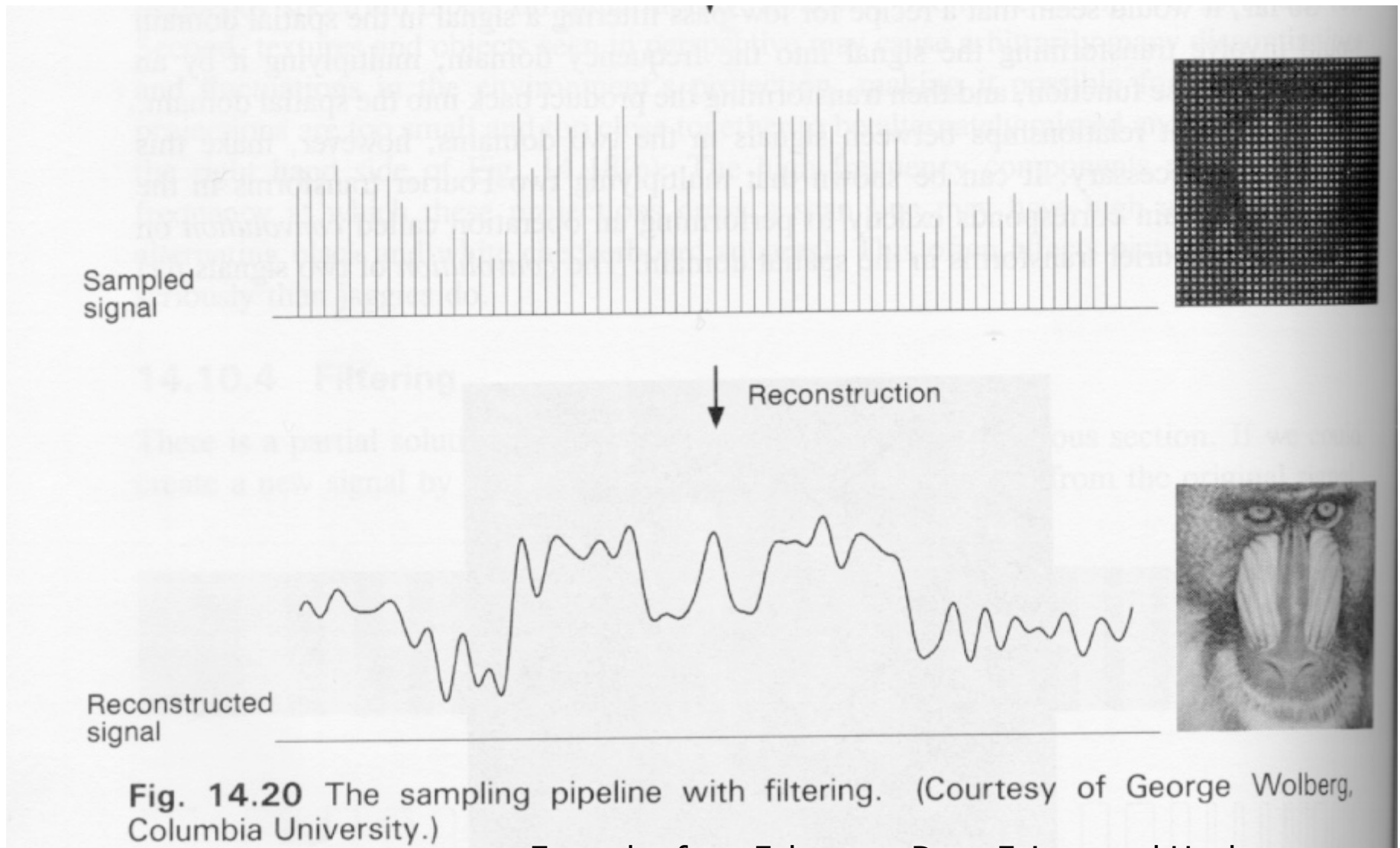
Aliasing

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Low-Pass Filtering

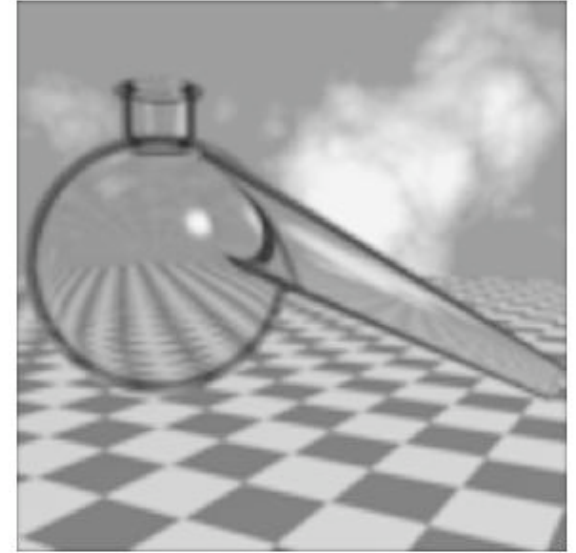
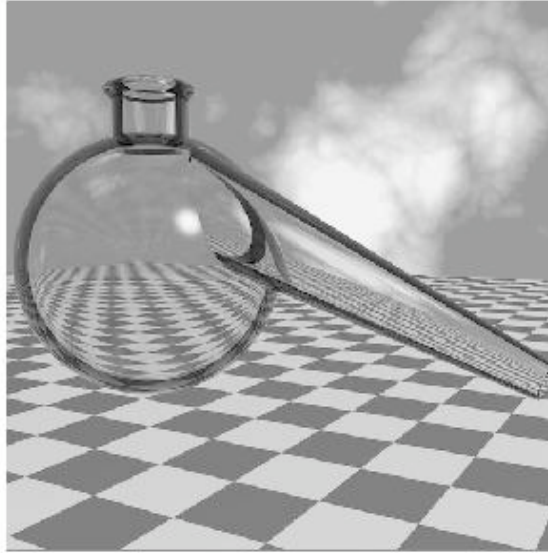


Low-Pass Filtering

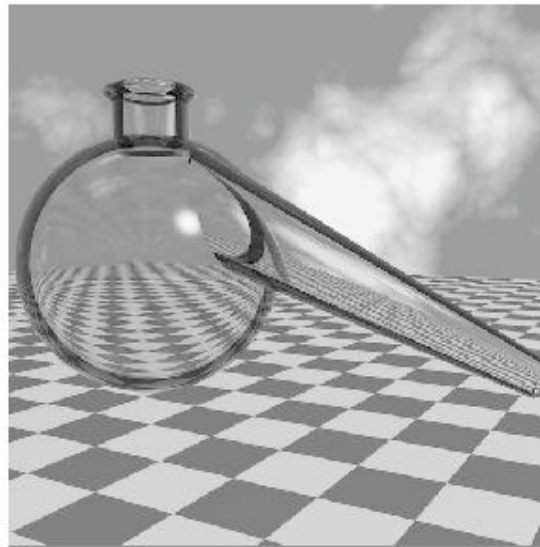


Filtering

- low pass
 - blur



- high pass
 - edge finding

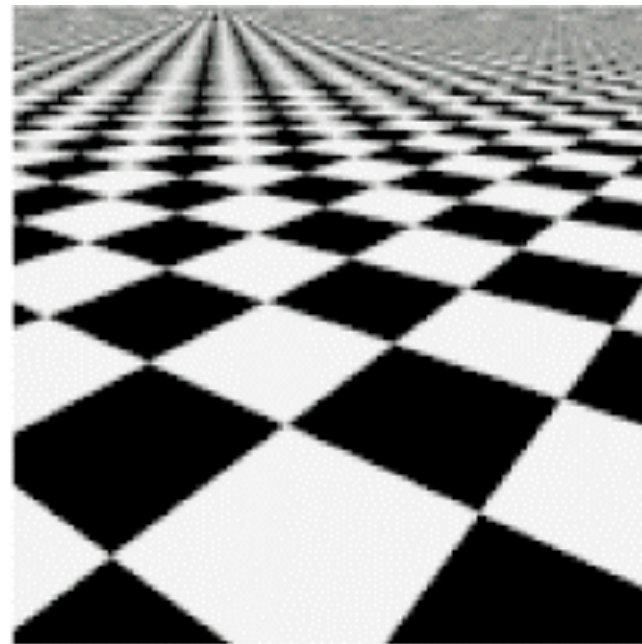


Texture Antialiasing

- texture mipmapping: low pass filter



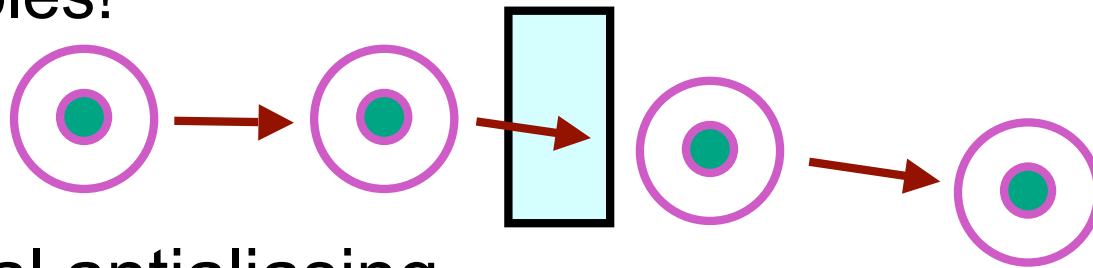
(a)



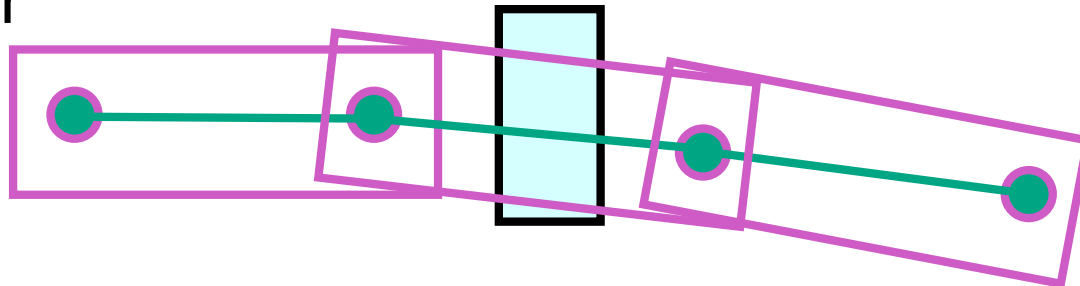
(b)

Temporal Antialiasing

- subtle point: collision detection algorithms for finding collisions *in time* as much as space
- temporal sampling
 - aliasing: can miss collision completely with point samples!



- temporal antialiasing
 - test line segment representing motion of object center



Modern Hardware

- use nice slides by Gordon Wetzstein
 - lecture 23 from
 - <http://www.ugrad.cs.ubc.ca/~cs314/Vjan2009/>
 - slides, downloadable demos