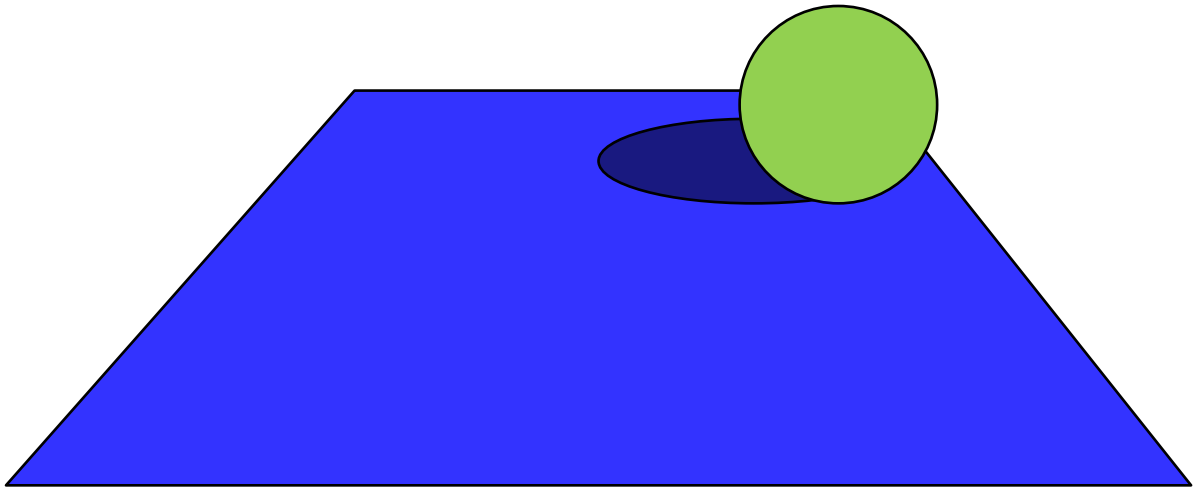
Shadows

CS418 Computer Graphics

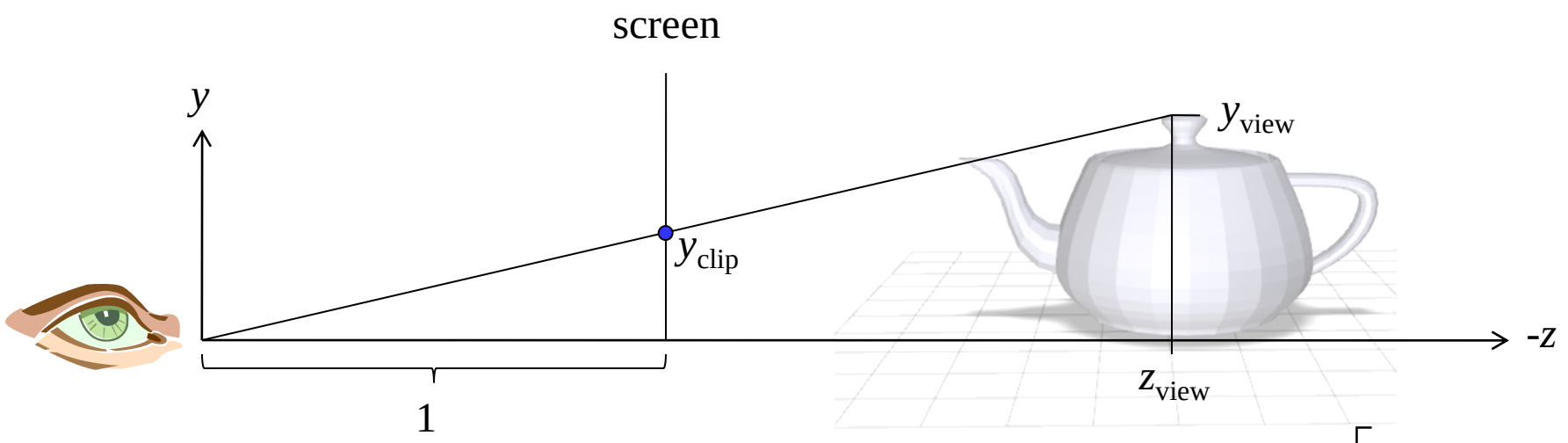
John C. Hart

Shadowing

- Shadows indicate light occlusion
- Fix object positions relative to each other

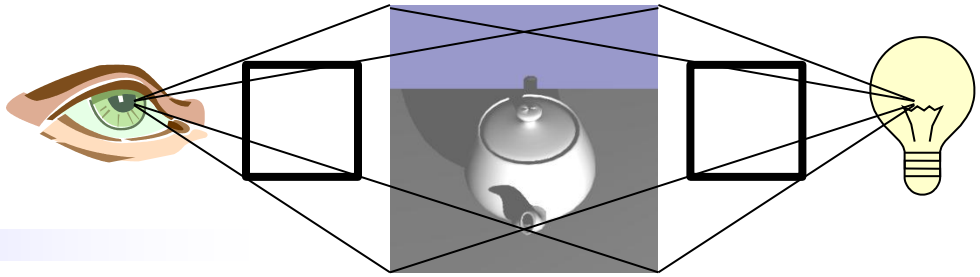


Perspective Distortion



$$y_{clip} = \frac{y_{view}}{-z_{view}} \Rightarrow \begin{bmatrix} 1 & & & \\ & 1 & & \\ & & \alpha & \beta \\ & & -1 & 0 \end{bmatrix} \begin{bmatrix} x_{view} \\ y_{view} \\ z_{view} \\ 1 \end{bmatrix} = \begin{bmatrix} x_{view} \\ y_{view} \\ \alpha z_{view} + \beta \\ -z_{view} \end{bmatrix} \equiv \begin{bmatrix} \frac{x_{view}}{-z_{view}} \\ \frac{y_{view}}{-z_{view}} \\ -\alpha - \frac{\beta}{z_{view}} \\ 1 \end{bmatrix}$$

Shadow Buffer



- Williams, SIGGRAPH 78
- Render scene twice from viewpoint

  $(x,y,z)_{screen} = WPV\ (x,y,z)_{world}$

  – Once with light source on

  – Once only with ambient

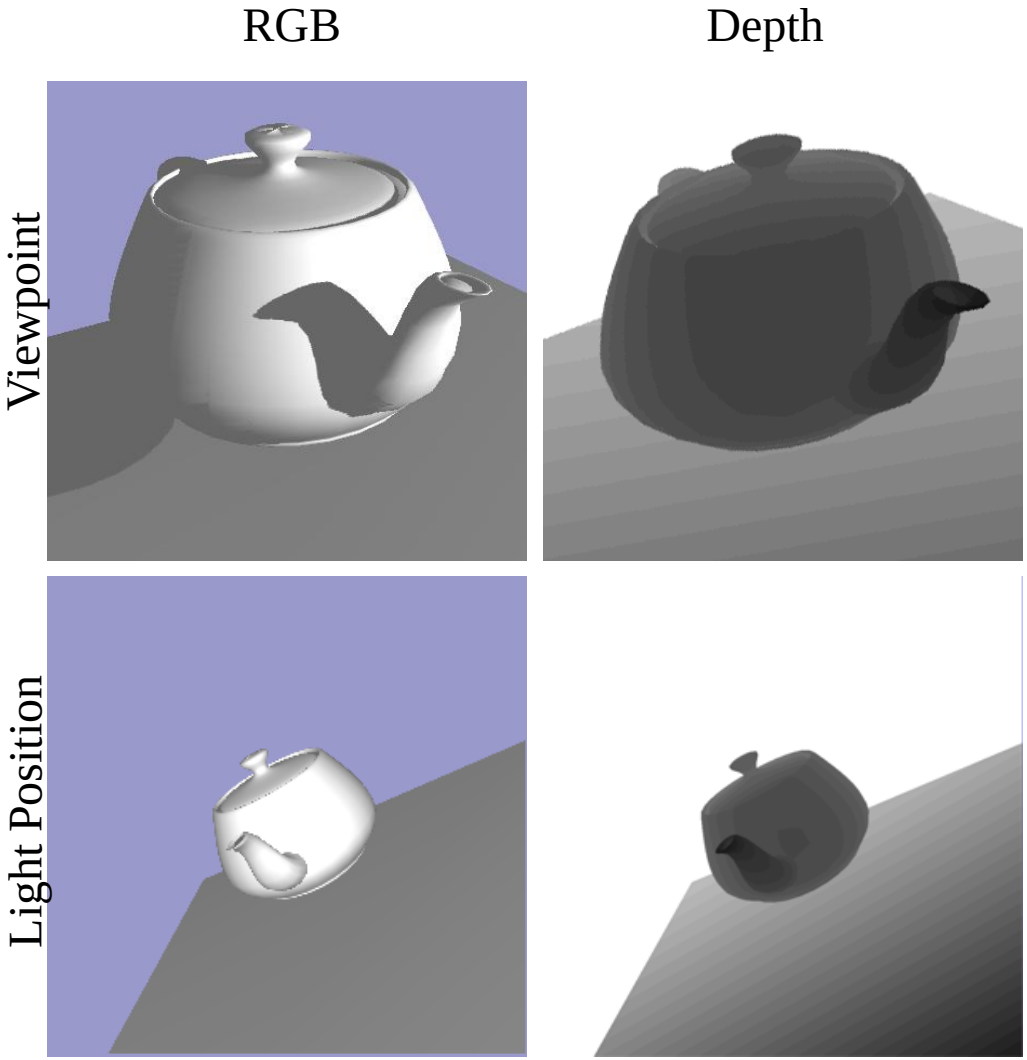
  – Save a z-buffer
- Render scene from light position

  $(x,y,z)_{light} = W_l P_l V_l\ (x,y,z)_{world}$

  – Save only z-buffer
- For each viewpoint image pixel compute

$(x,y,z)_{vis} = W_l P_l V_l\ V^{-1} P^{-1} W^{-1}\ (x,y,z)_{screen}$

- If $z_{vis} < z_{light}$ at $(x,y)_{vis} = (x,y)_{light}$
- Then pixel is in shadow



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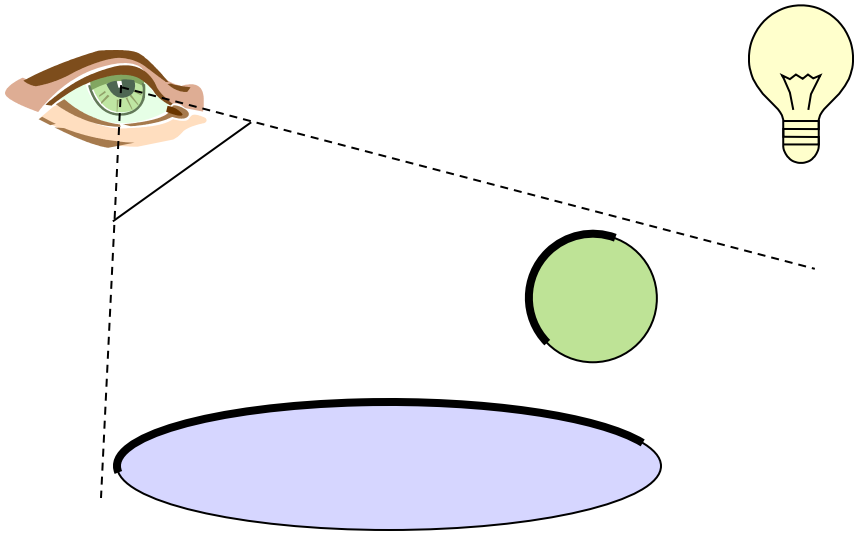

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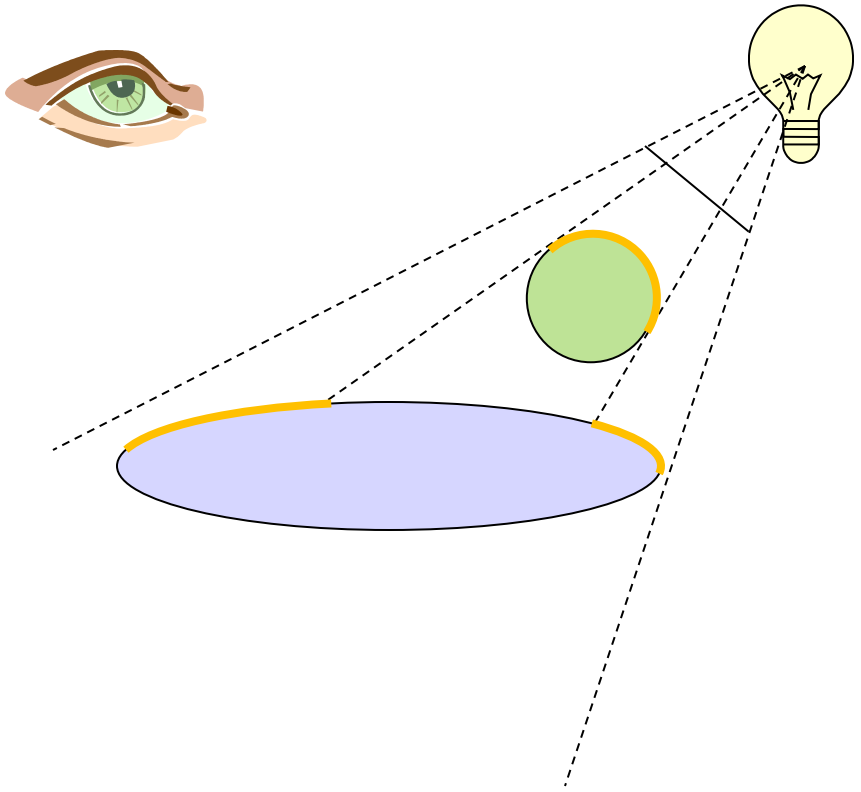

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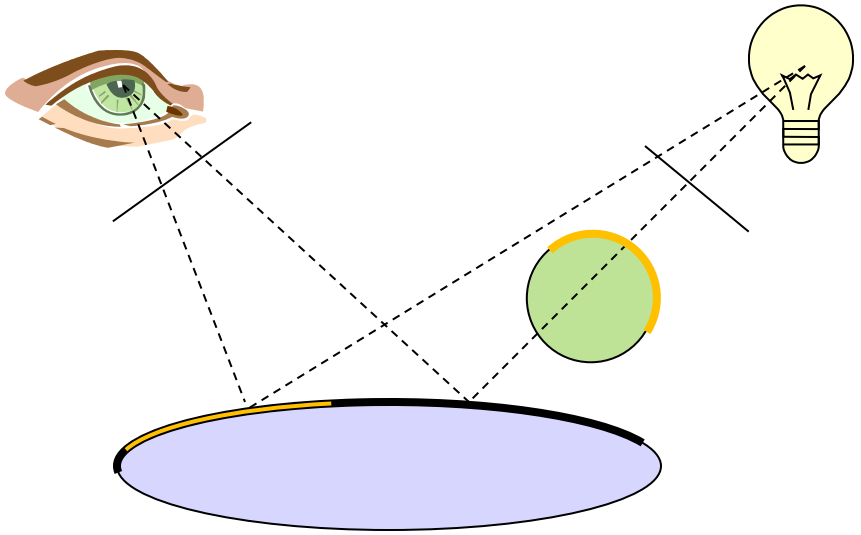

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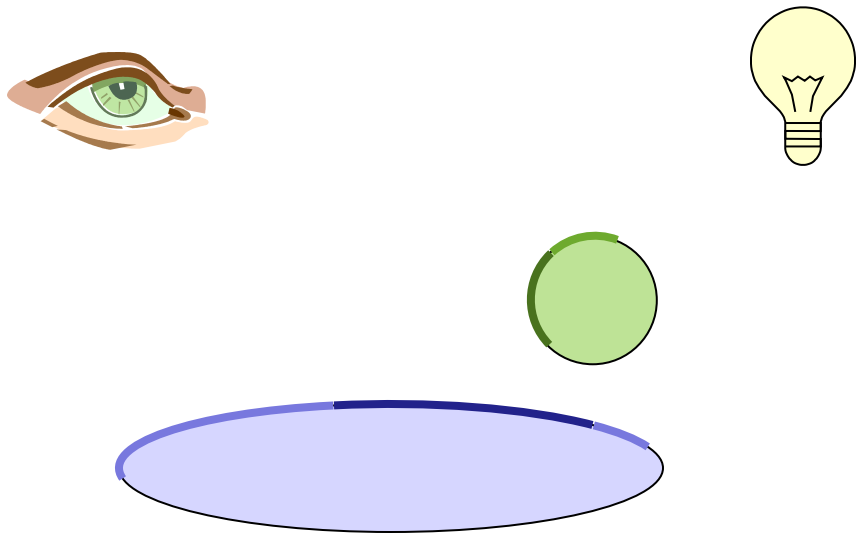
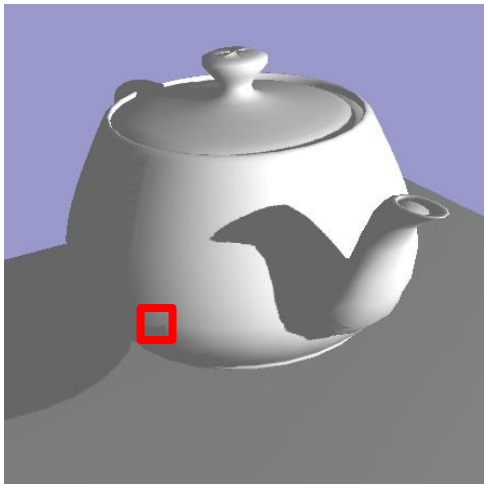
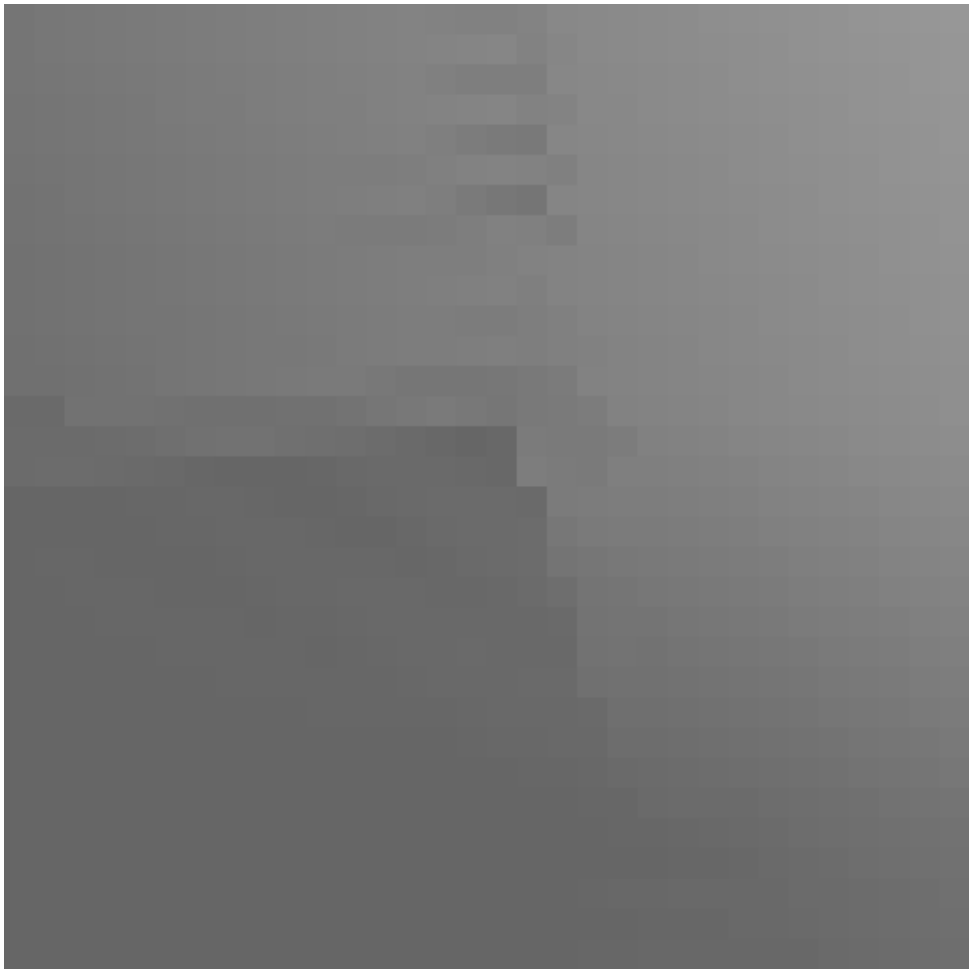


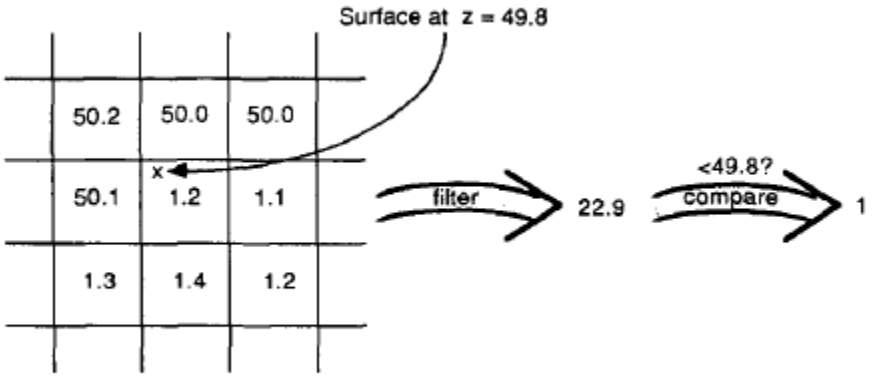
Numerical Analysis



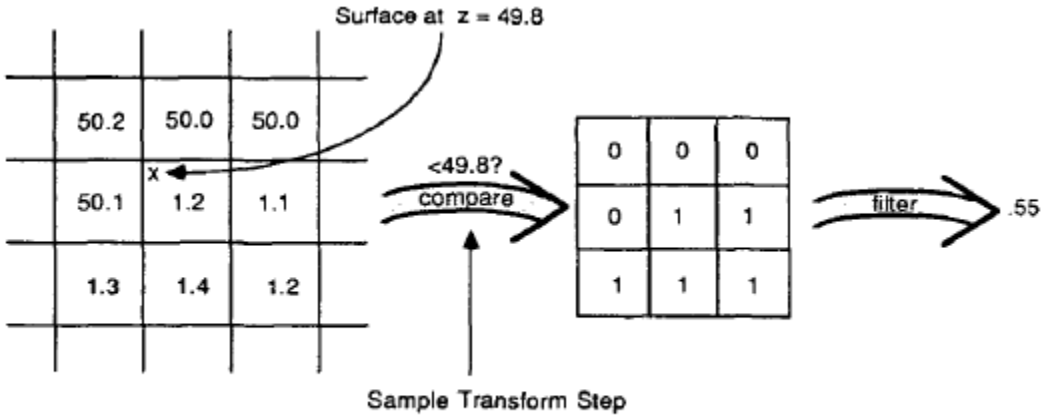


Percentage Closer Filtering

- Reeves, Salesin, Cook, SIGGRAPH 87
- Shadow aliasing occurs when numerical inaccuracy and discretization causes sample to compare to the wrong depth near an edge
- Can be fixed by comparing sample in a neighborhood (e.g. 3x3 pixels) and filtering the binary shadow answer
- Can also be extended to generate soft shadows



a) Ordinary texture map filtering. Does not work for depth maps.



b) Percentage closer filtering.