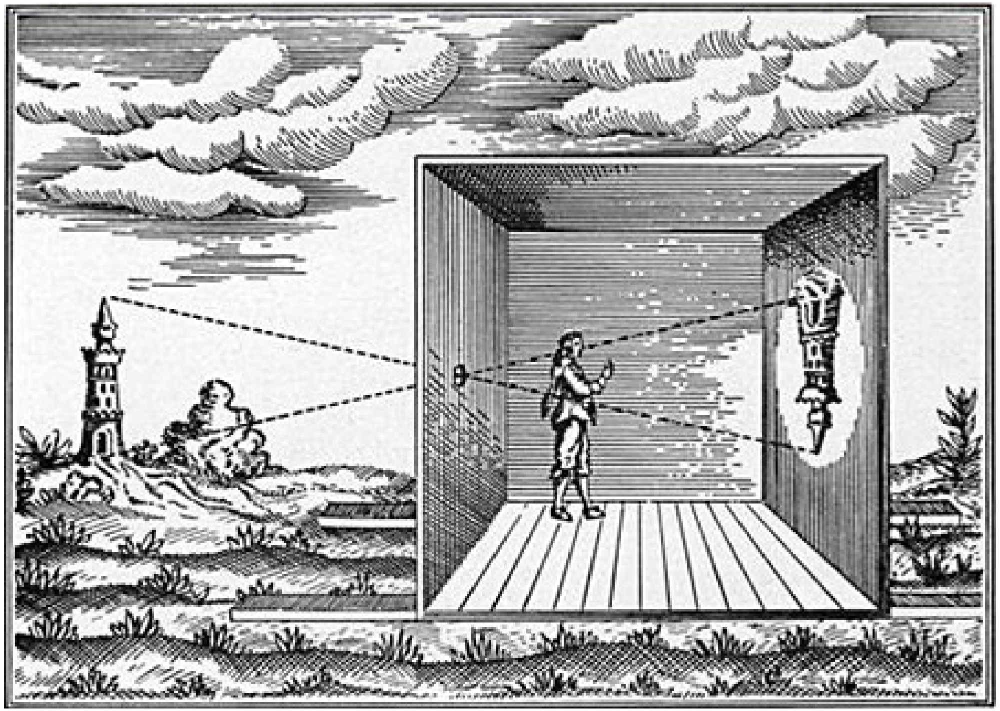
Dem Licht auf der Spur

Motivation: Architektur

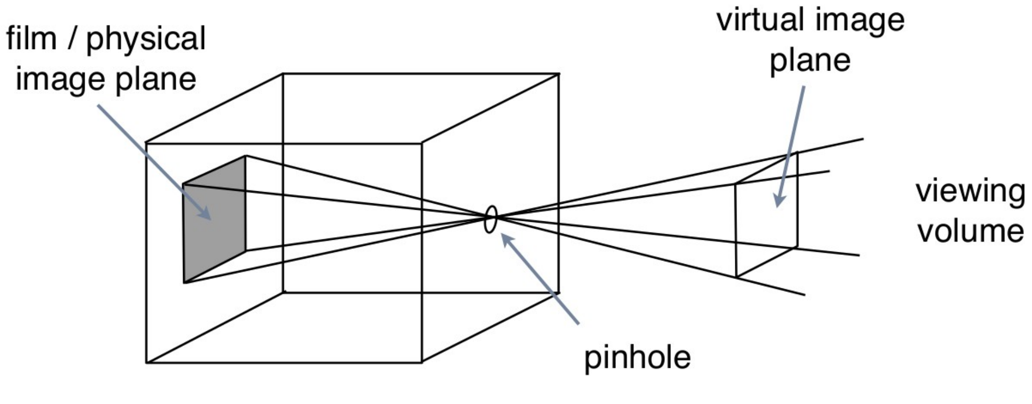
Motivation: Innenausstatter

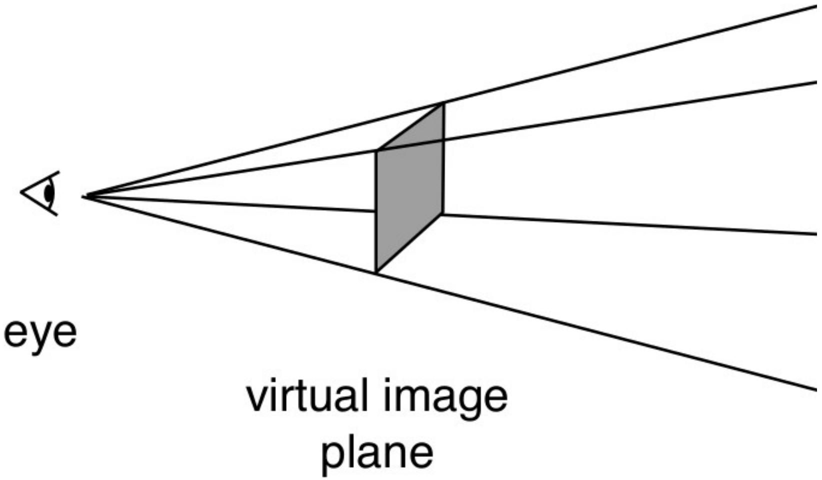
Motivation: Filme

Lochkamera



Kameramodell



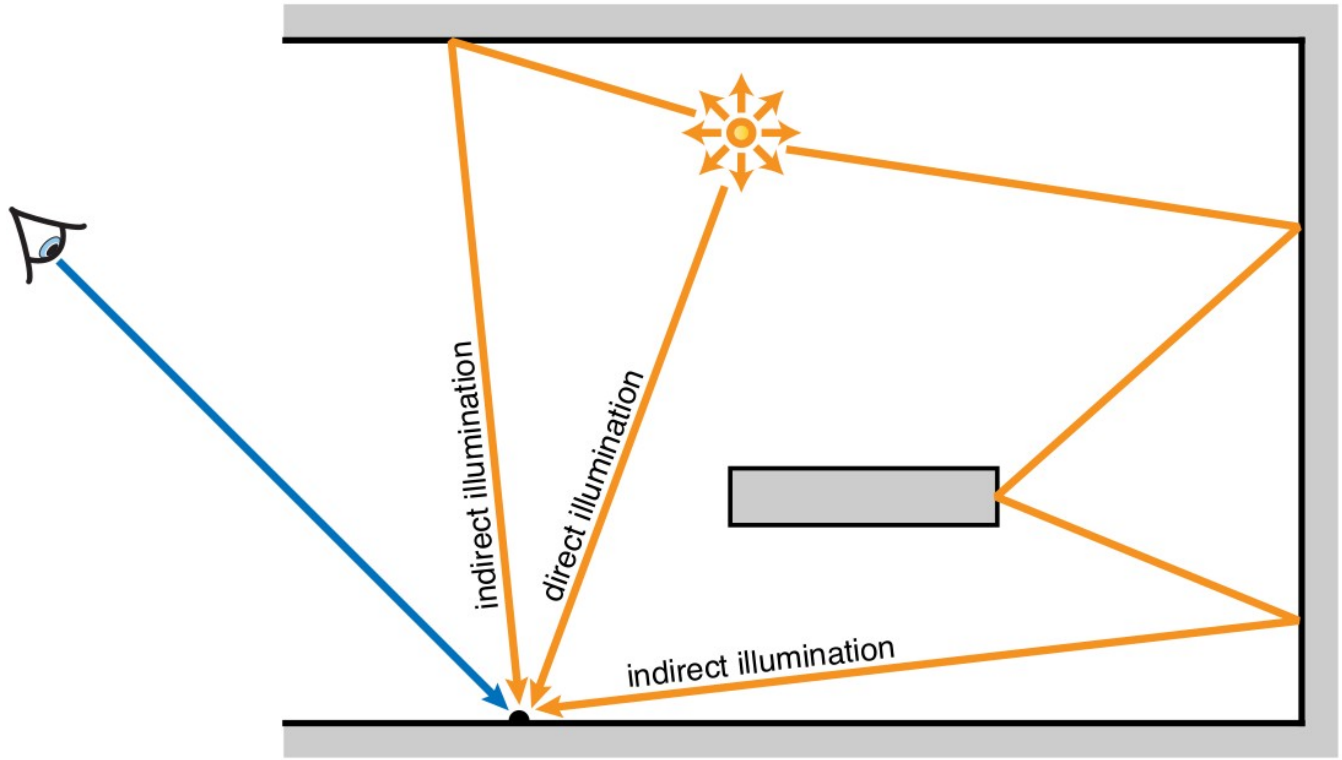


Lichtquellen

Lichtquellen

$$L_e(x, \omega_r)$$

Direktes und Indirektes Licht



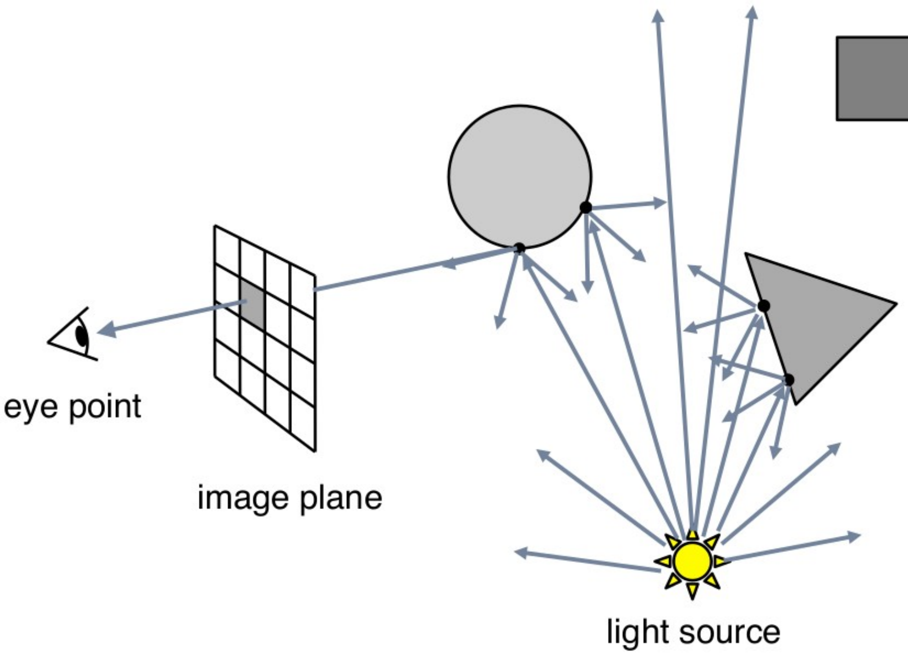
Direktes und Indirektes Licht

Direct illumination

Indirect illumination

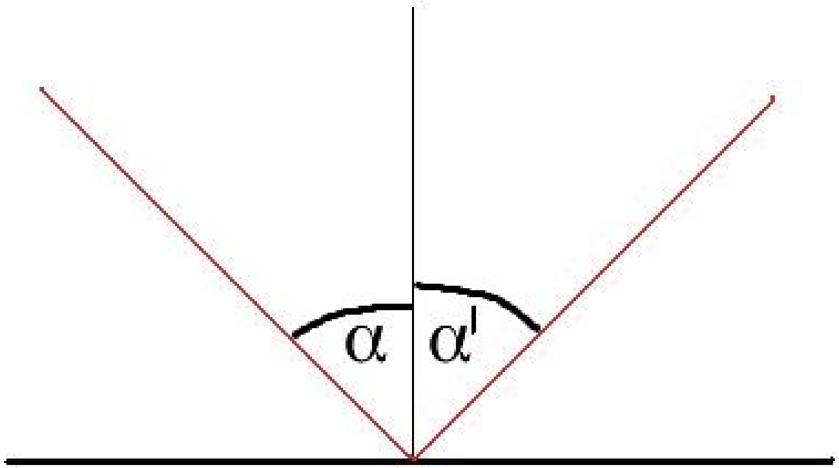
Direct + indirect illumination

Light Tracing

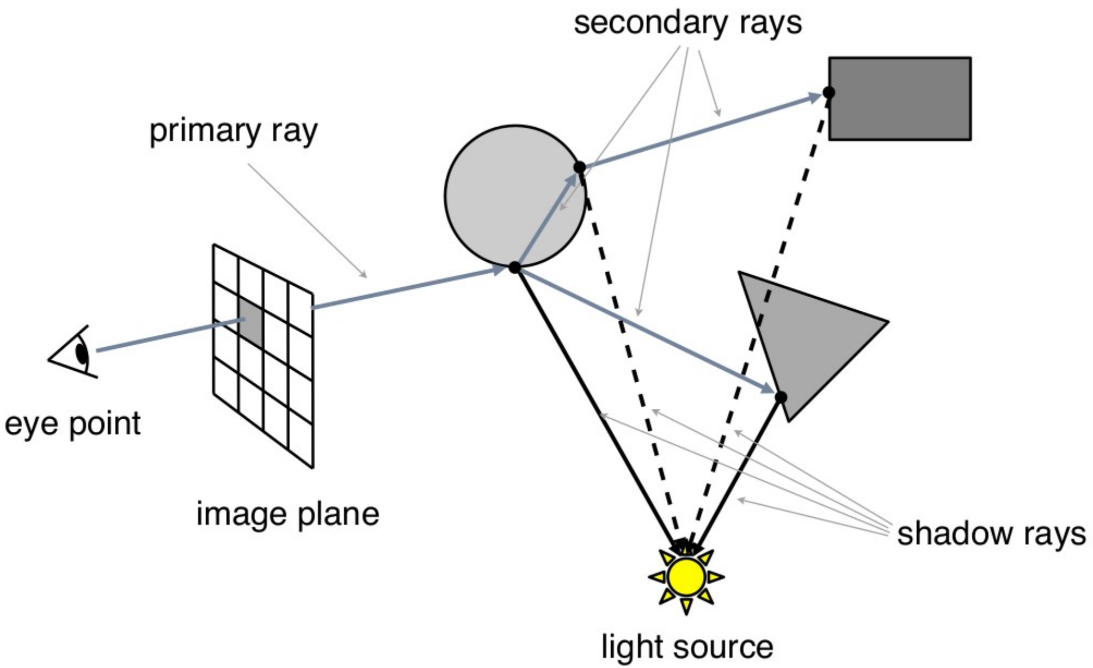


Reflexionsgesetz

$$\alpha = \alpha'$$

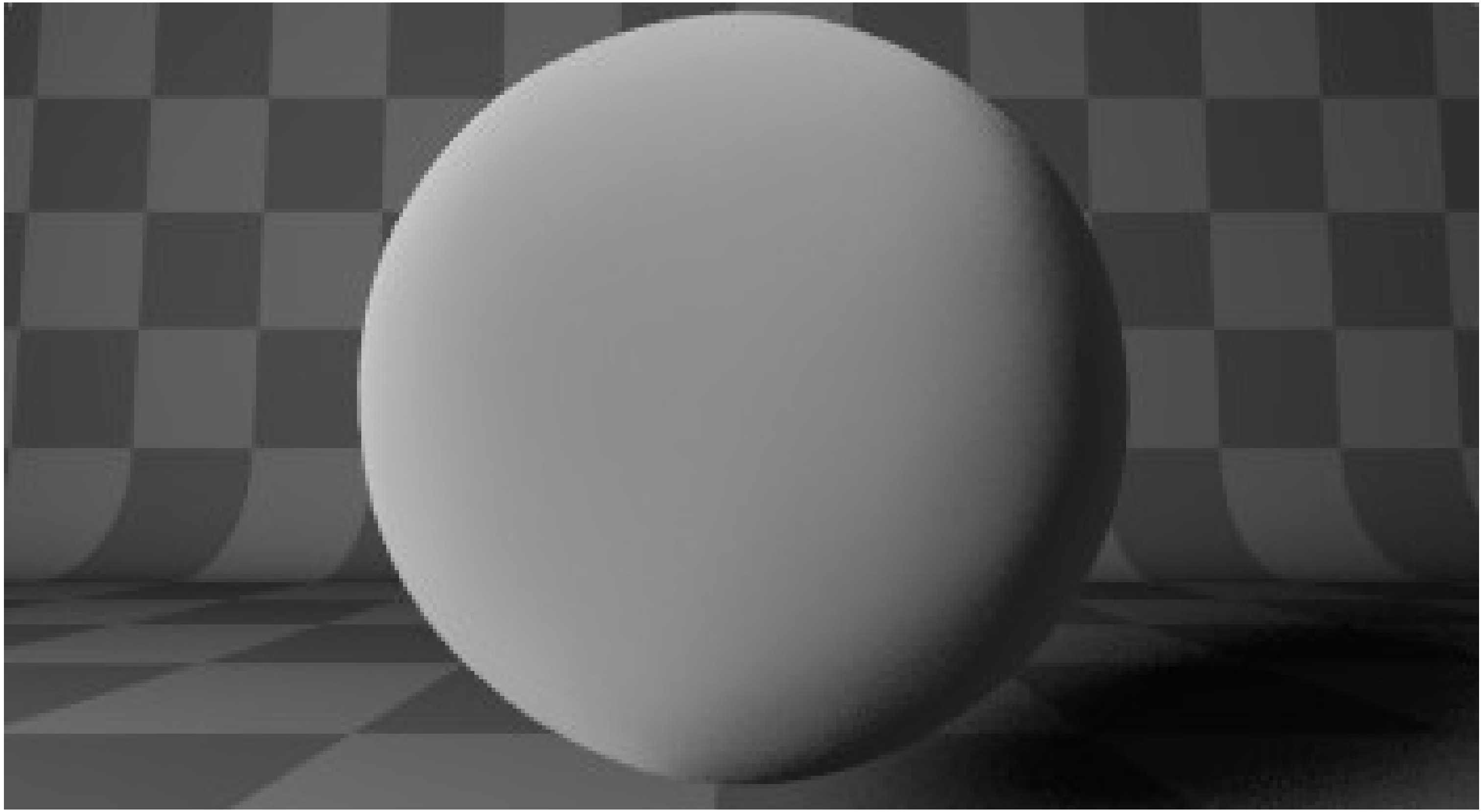


Camera Tracing

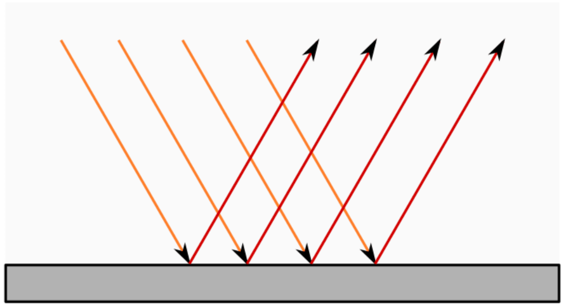


Glatte Reflexion

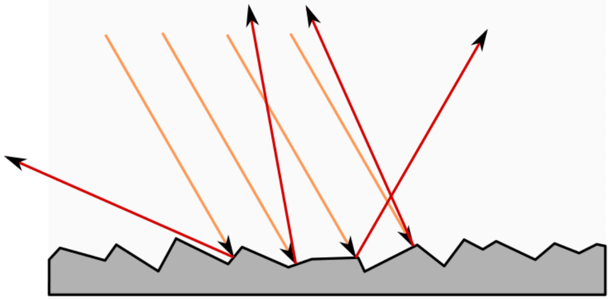
Raue Reflexion



Glatte und Raue Reflexion

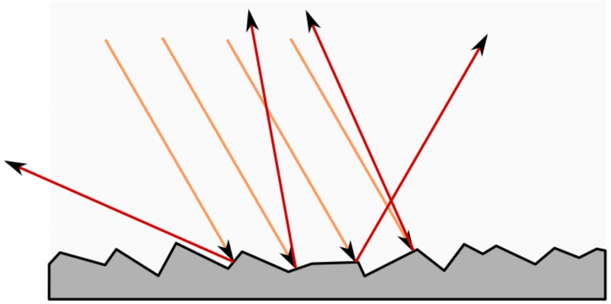


Glatter Spiegel
Direkte Reflektion



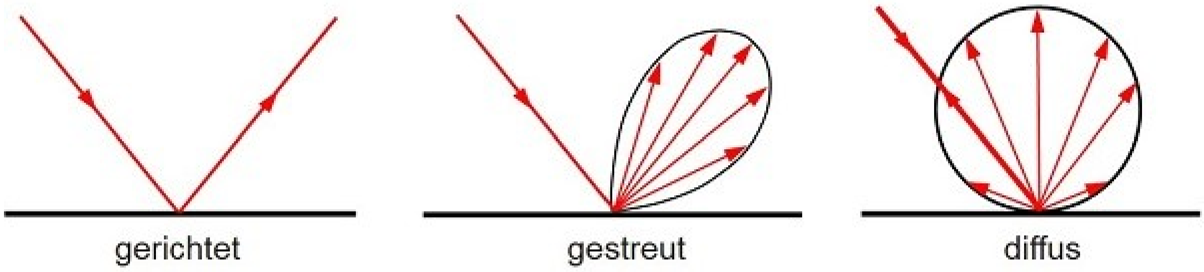
Rauher Spiegel
Diffuse Reflektion

Glatte und Raue Reflexion

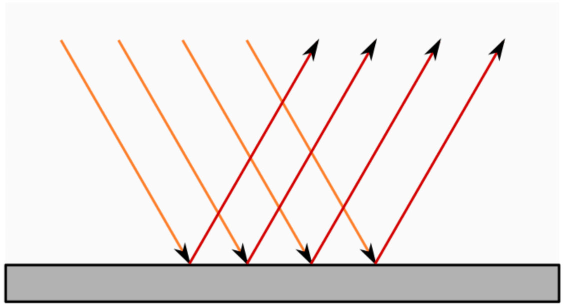


Glatter Spiegel
Direkte Reflektion

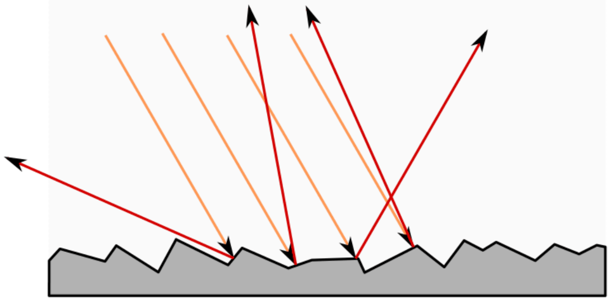
Rauher Spiegel
Diffuse Reflektion



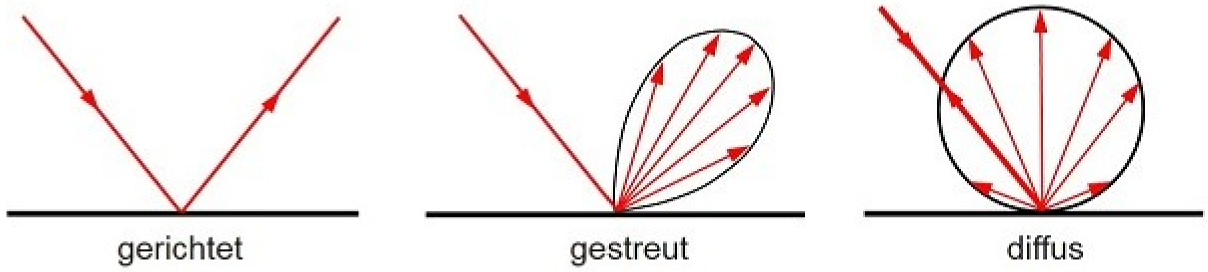
Glatte und Raue Reflexion



Glatter Spiegel
Direkte Reflektion

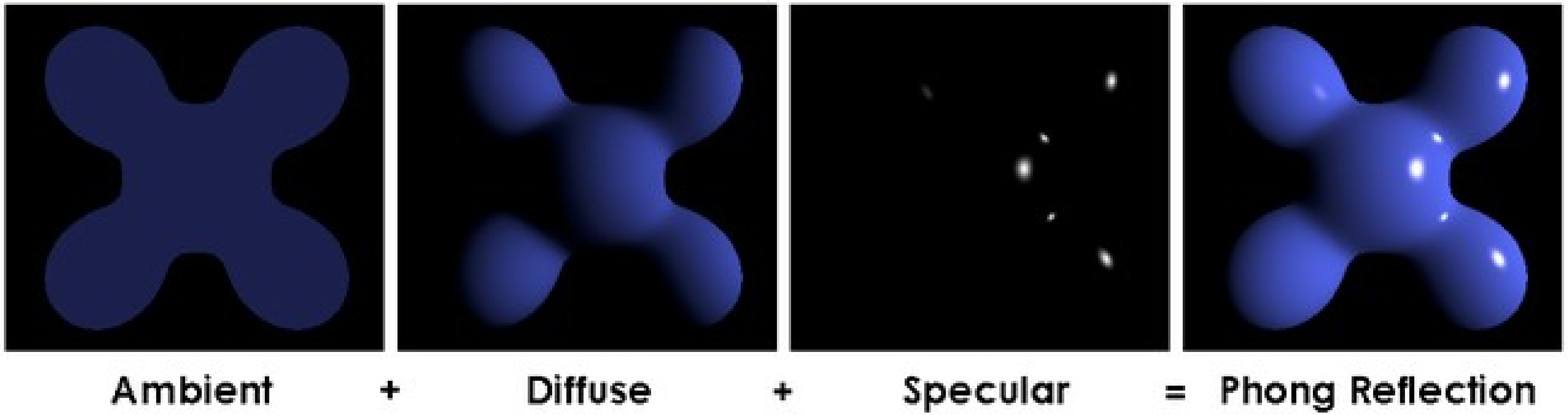


Rauher Spiegel
Diffuse Reflektion

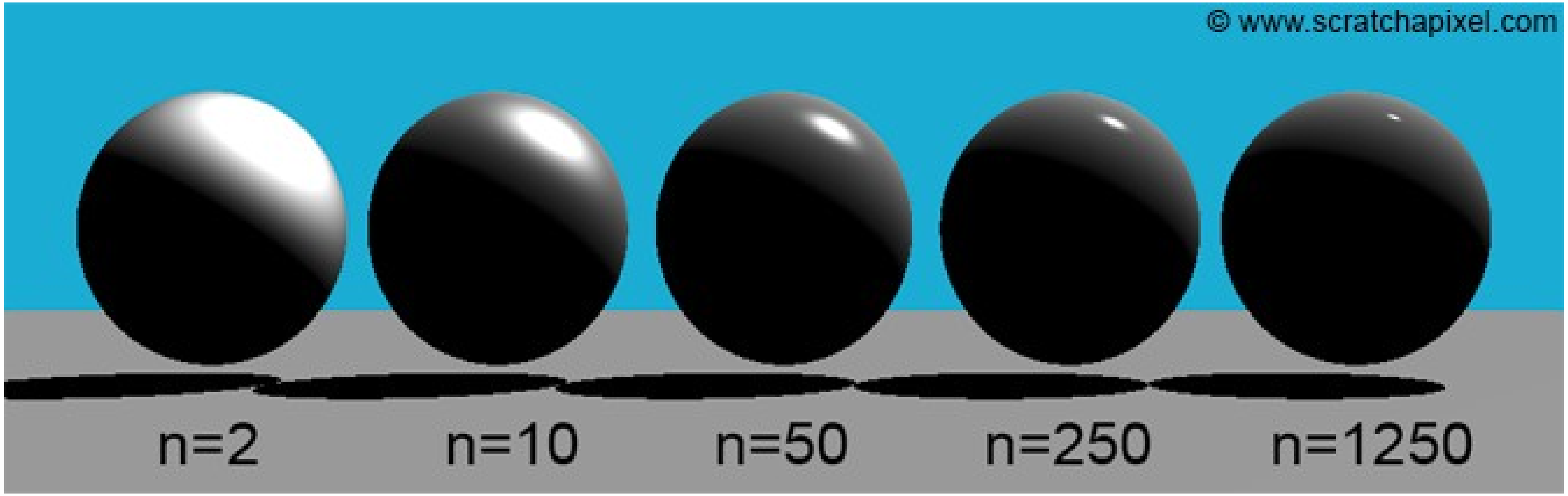


$$f_r(x, \omega_i, \omega_r)$$

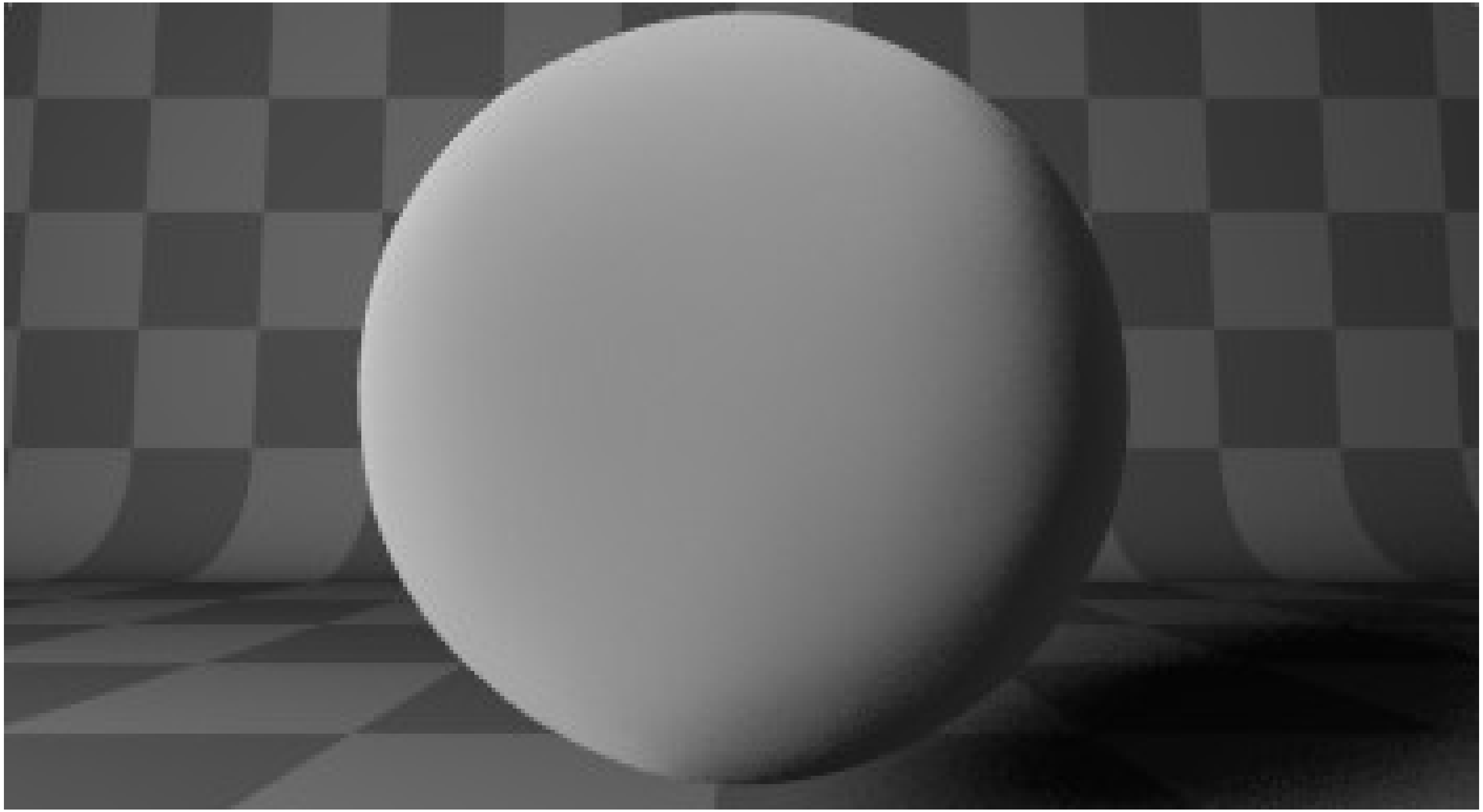
Phong Shading



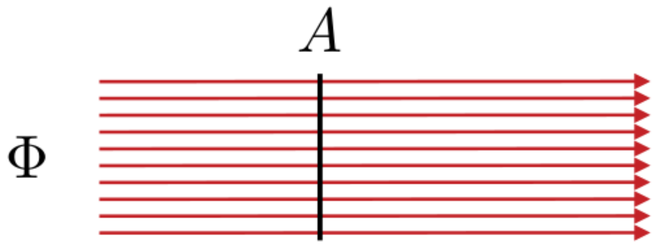
Phong Shading



Licht und Schatten

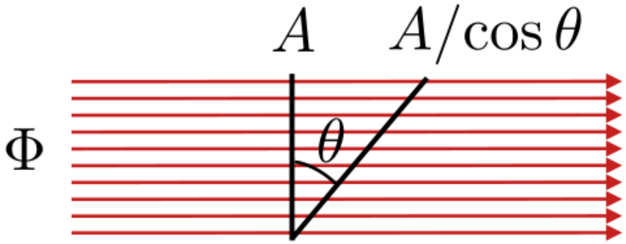


Lambert‘s Cosinus Gesetz

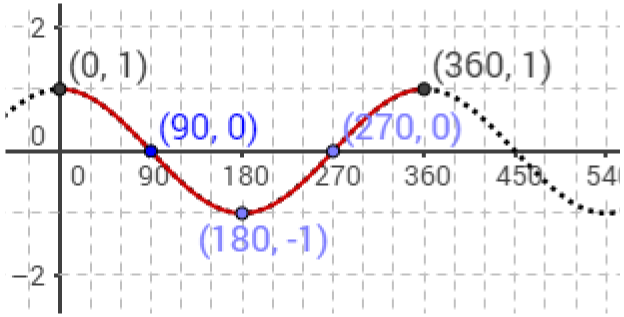


$$E = \frac{\Phi}{A}$$

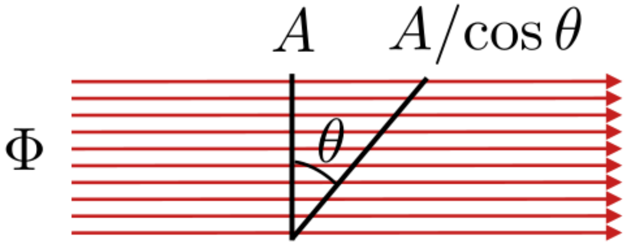
Lambert‘s Cosinus Gesetz



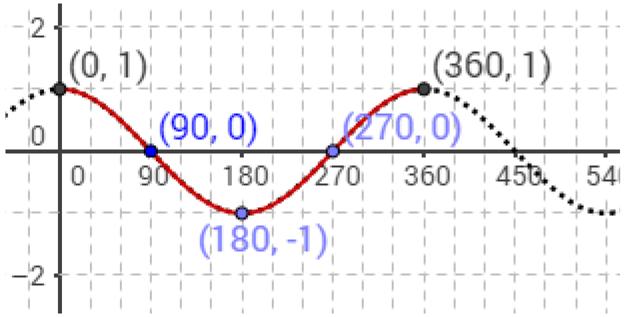
$$E = \frac{\Phi}{A/\cos\theta} = \frac{\Phi}{A}\cos\theta$$



Lambert‘s Cosinus Gesetz

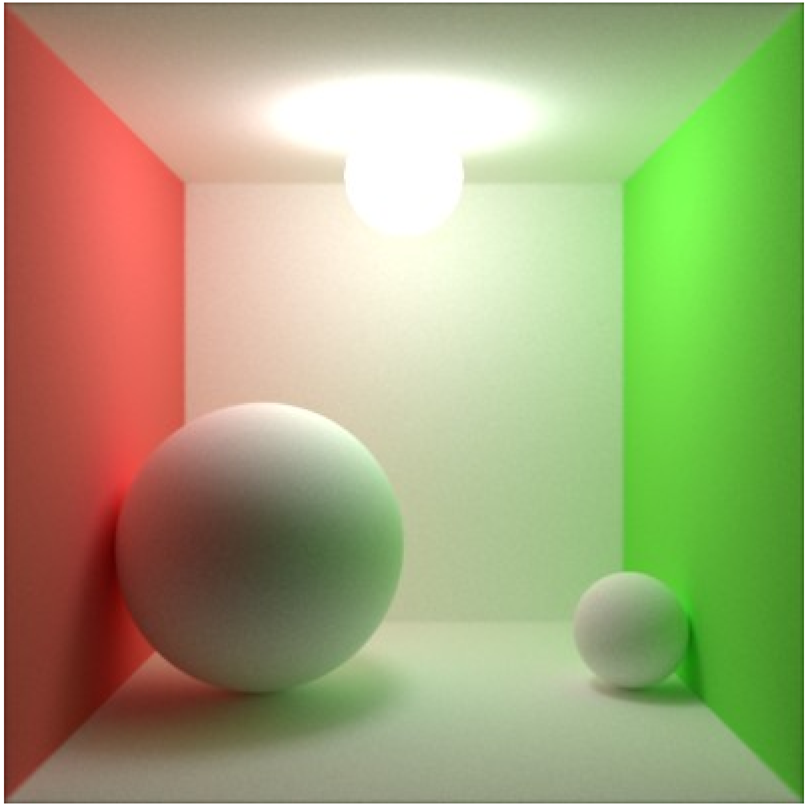


$$E = \frac{\Phi}{A/\cos\theta} = \frac{\Phi}{A}\cos\theta$$

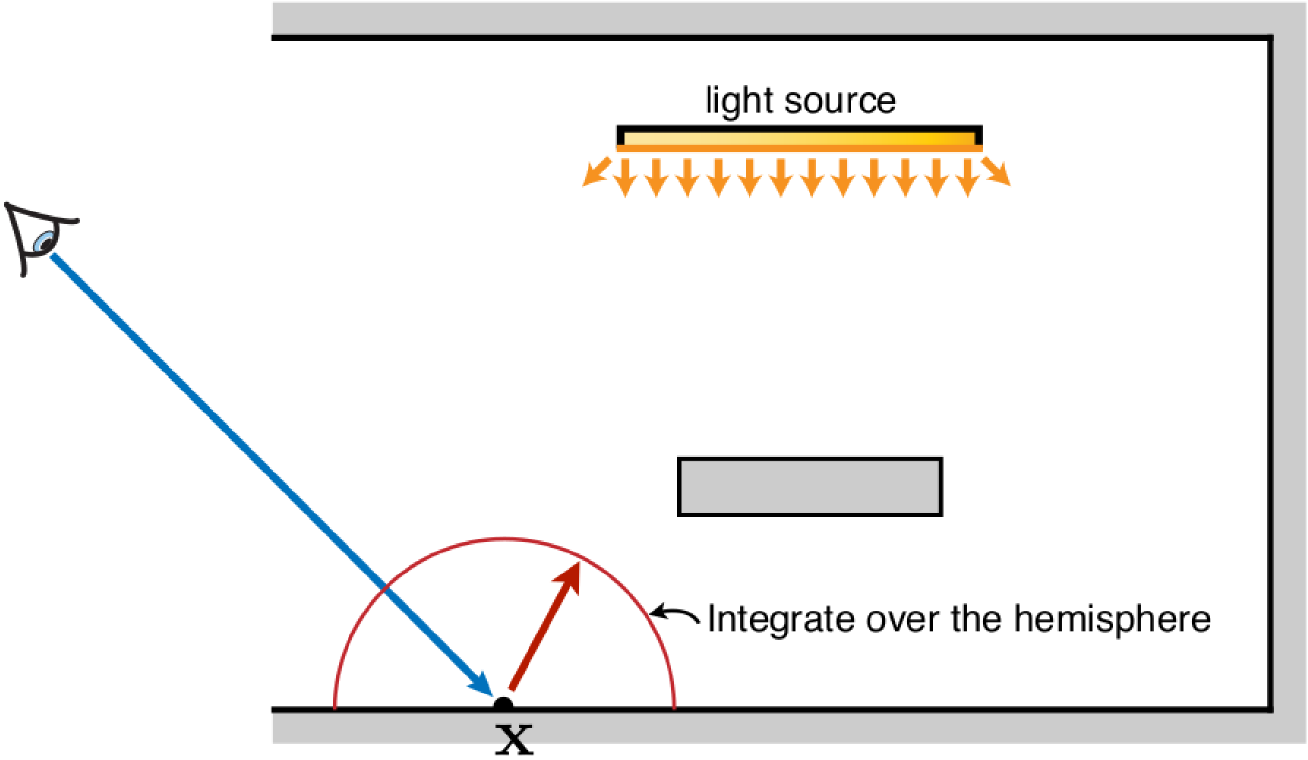


$$\boxed{L_i(x, \omega_i) * \cos(\theta_i)}$$

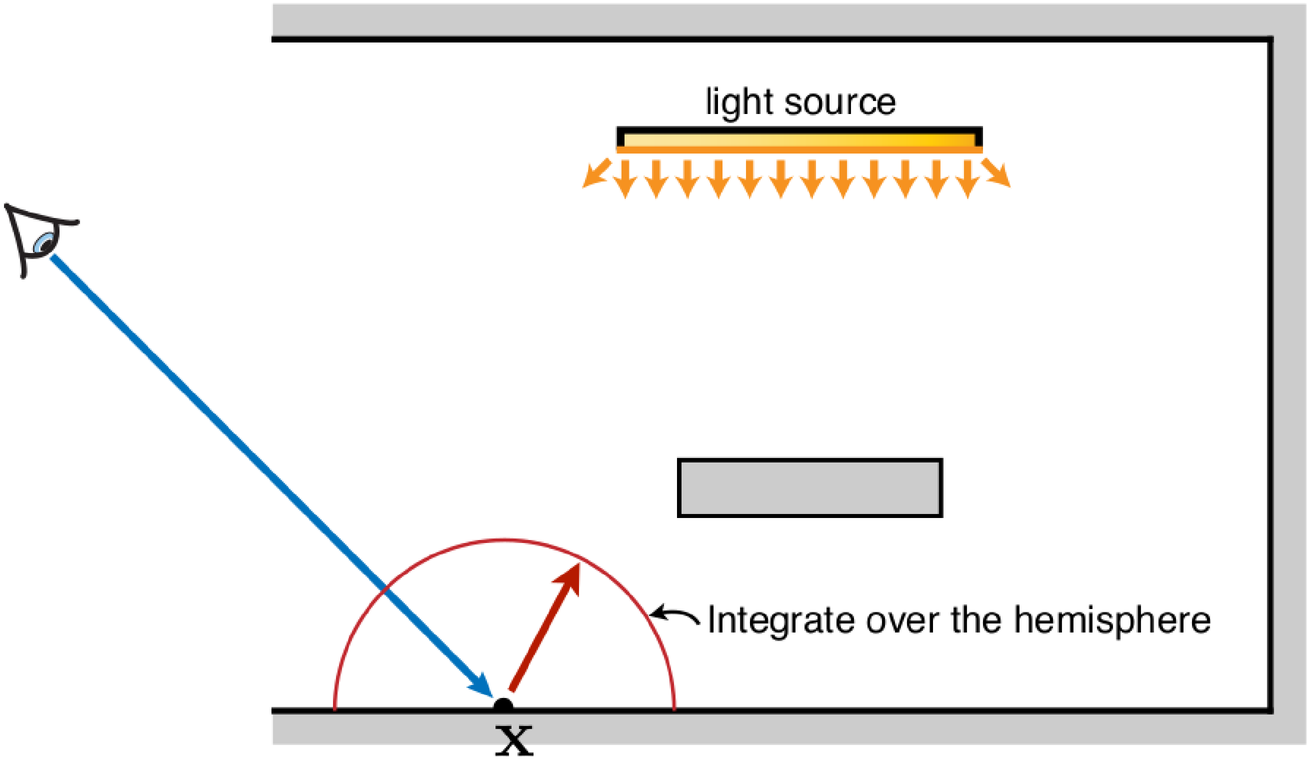
Indirektes Licht



Halbkugel

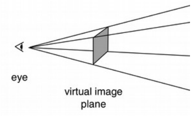


Halbkugel



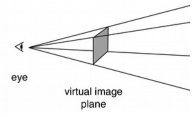
$$\int_{H^2} \square \, d\omega_i$$

Rendering Equation



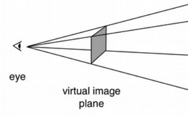
$$L_o(x, \omega_r) = \square$$

Rendering Equation

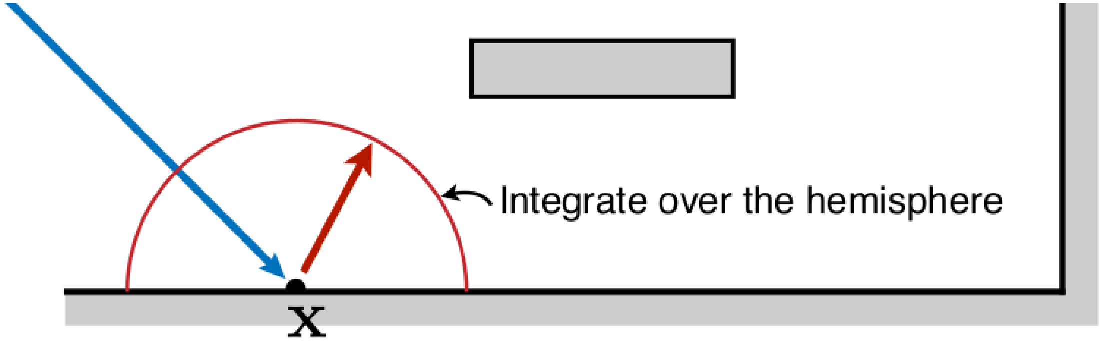


$$L_o(x, \omega_r) = \boxed{L_e(x, \omega_r)}$$

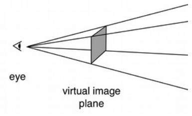
Rendering Equation



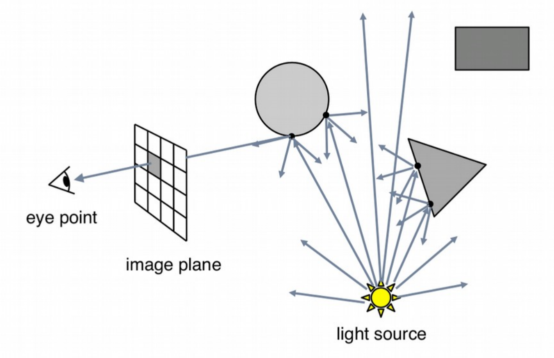
$$L_o(x,\omega_r) = L_e(x,\omega_r) + \int_{H^2} \qquad d\,\omega_i$$



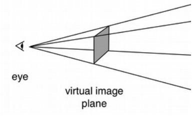
Rendering Equation



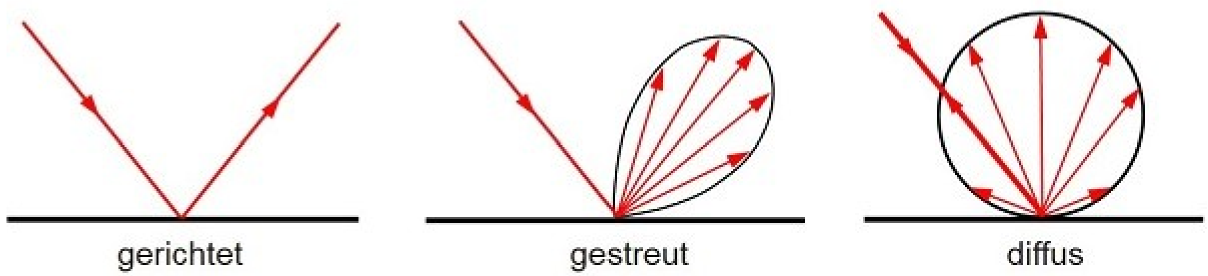
$$L_o(x,\omega_r) = L_e(x,\omega_r) + \int_{H^2} \boxed{L_i(x,\omega_i) * \cos(\theta_i)} * \qquad d\,\omega_i$$



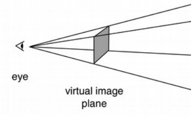
Rendering Equation



$$L_o(x,\omega_r)=L_e(x,\omega_r)+\int_{H^2} L_i(x,\omega_i)*\cos(\theta_i)*\boxed{f_r(x,\omega_i,\omega_r)}\,d\omega_i$$



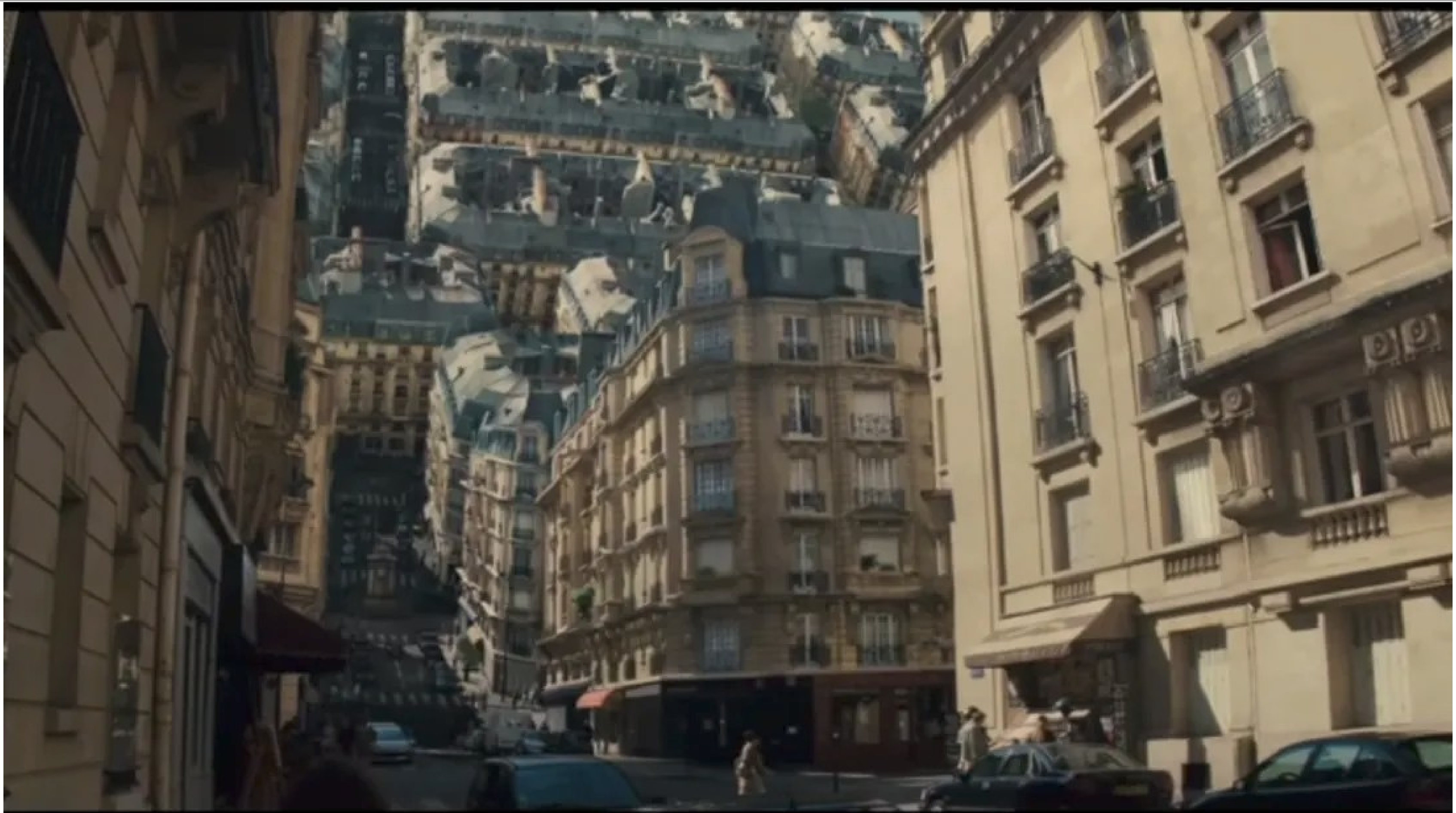
Rendering Equation



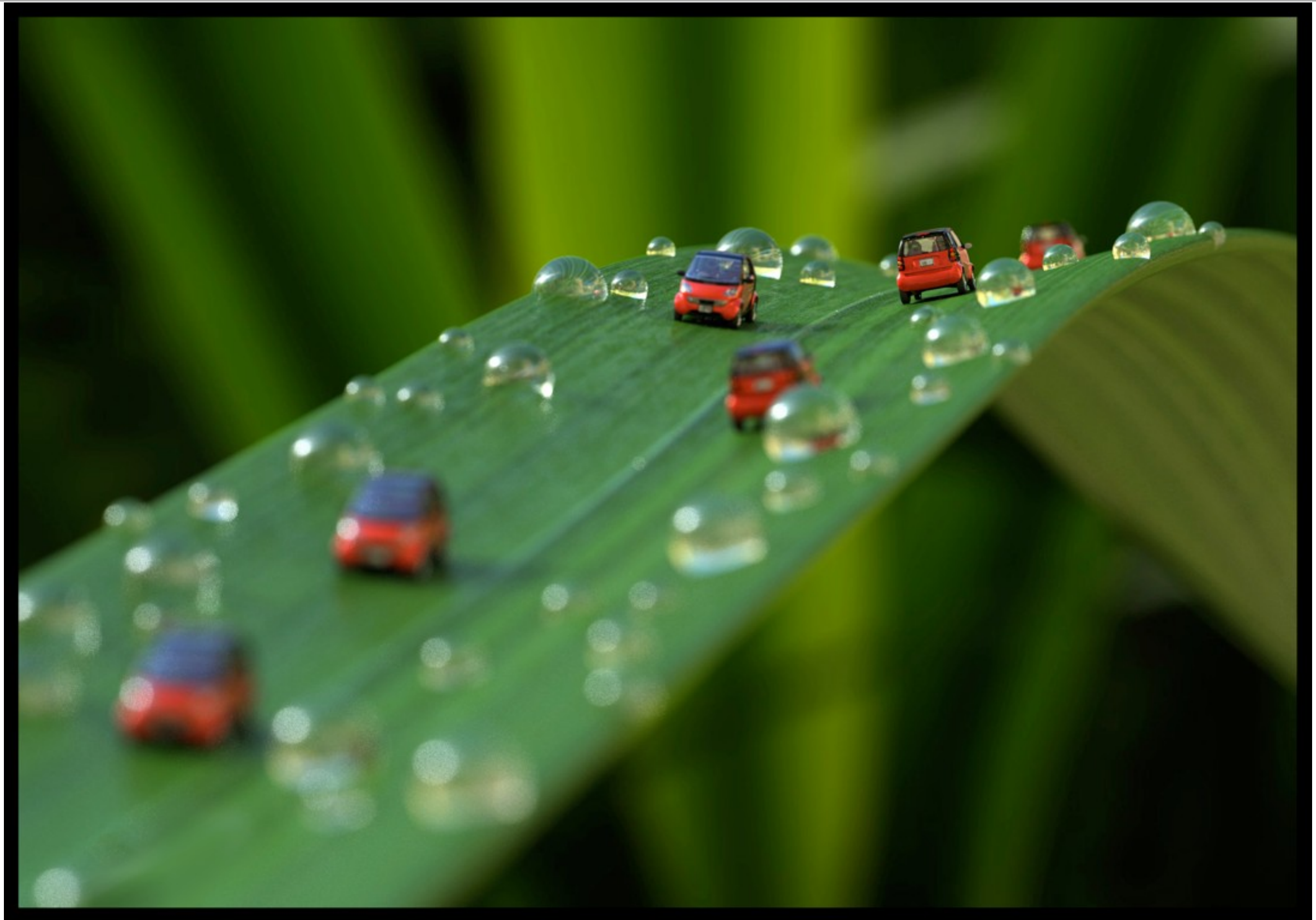
$$L_o(x,\omega_r) = \boxed{L_e(x,\omega_r)} + \boxed{\int_{H^2}} \boxed{f_r(x,\omega_i,\omega_r)} * \boxed{L_i(x,\omega_i) * \cos(\theta_i)} \boxed{d\,\omega_i}$$

Ergebnisse

Ergebnisse

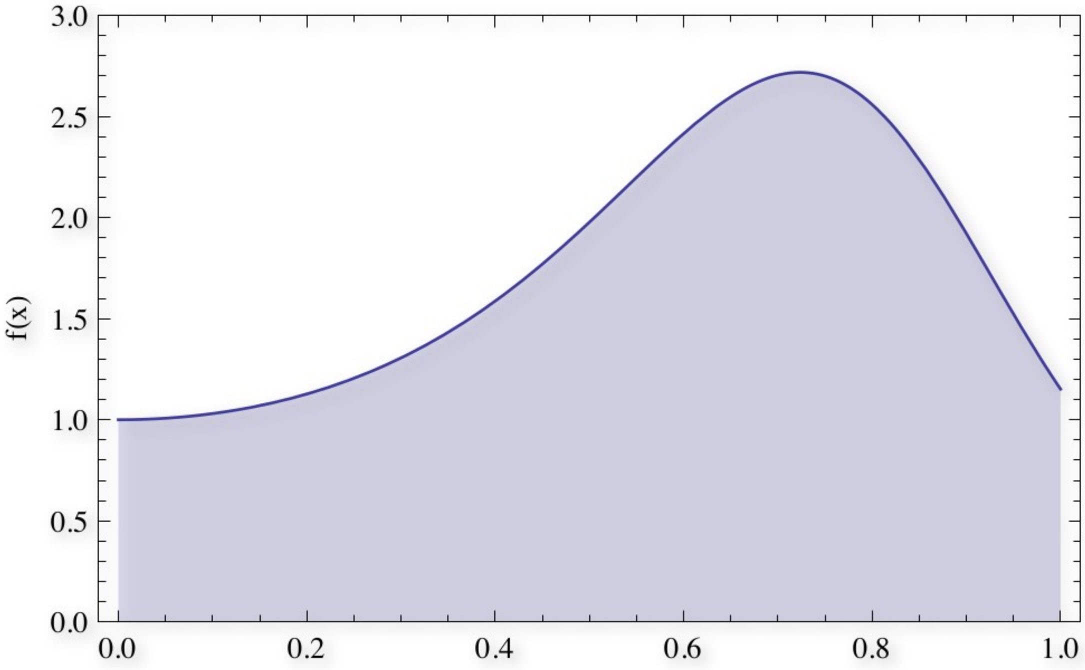


Ergebnisse

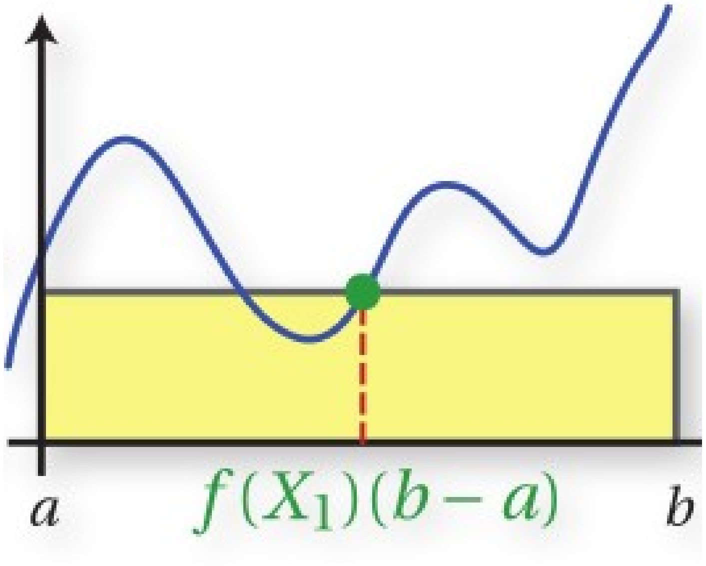


Integrale

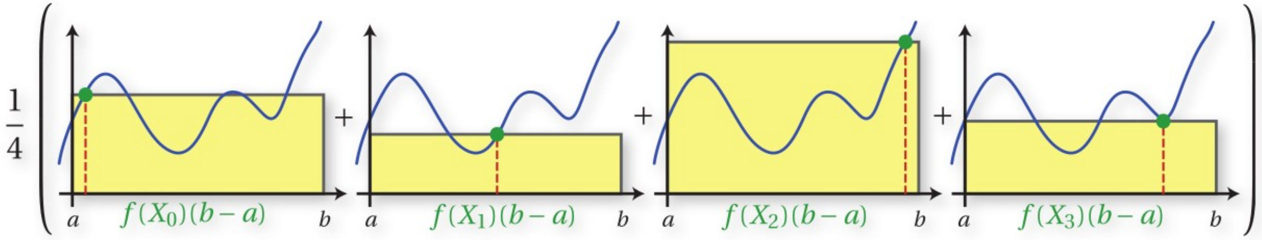
$$F = \int_0^1 e^{\sin(3x^2)}\,dx$$



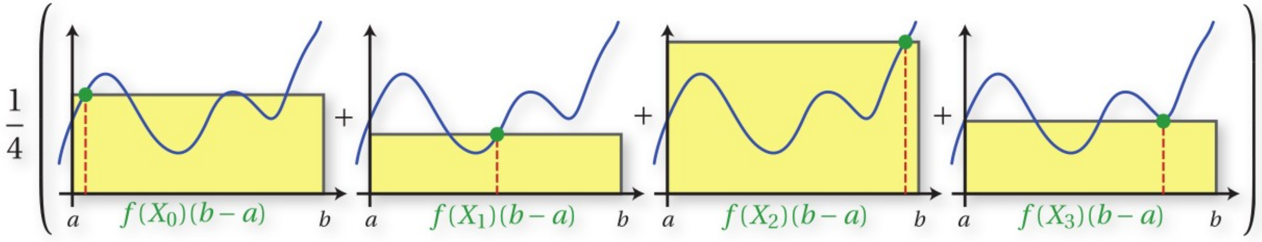
Monte Carlo

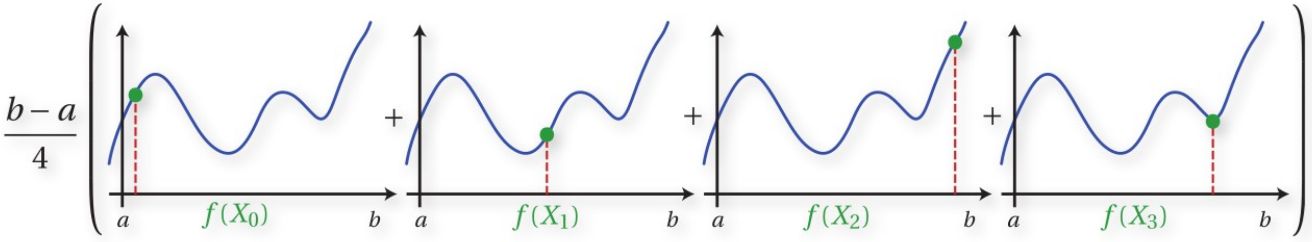


Monte Carlo

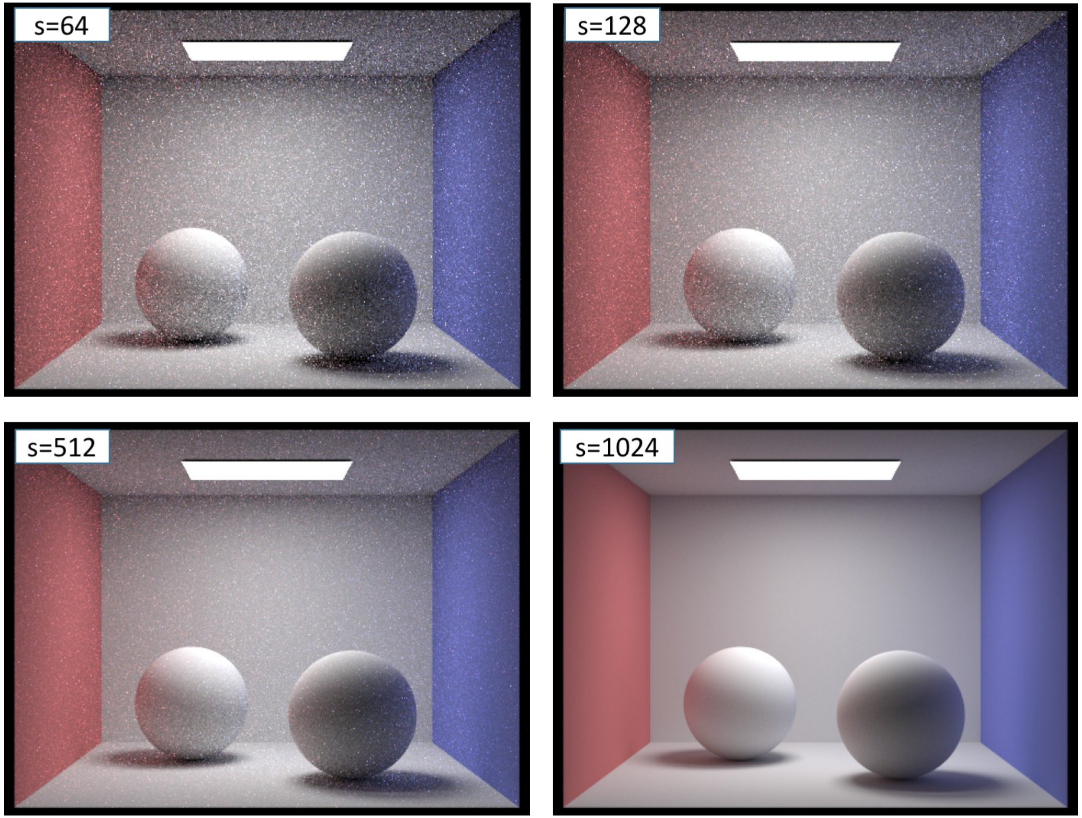


Monte Carlo

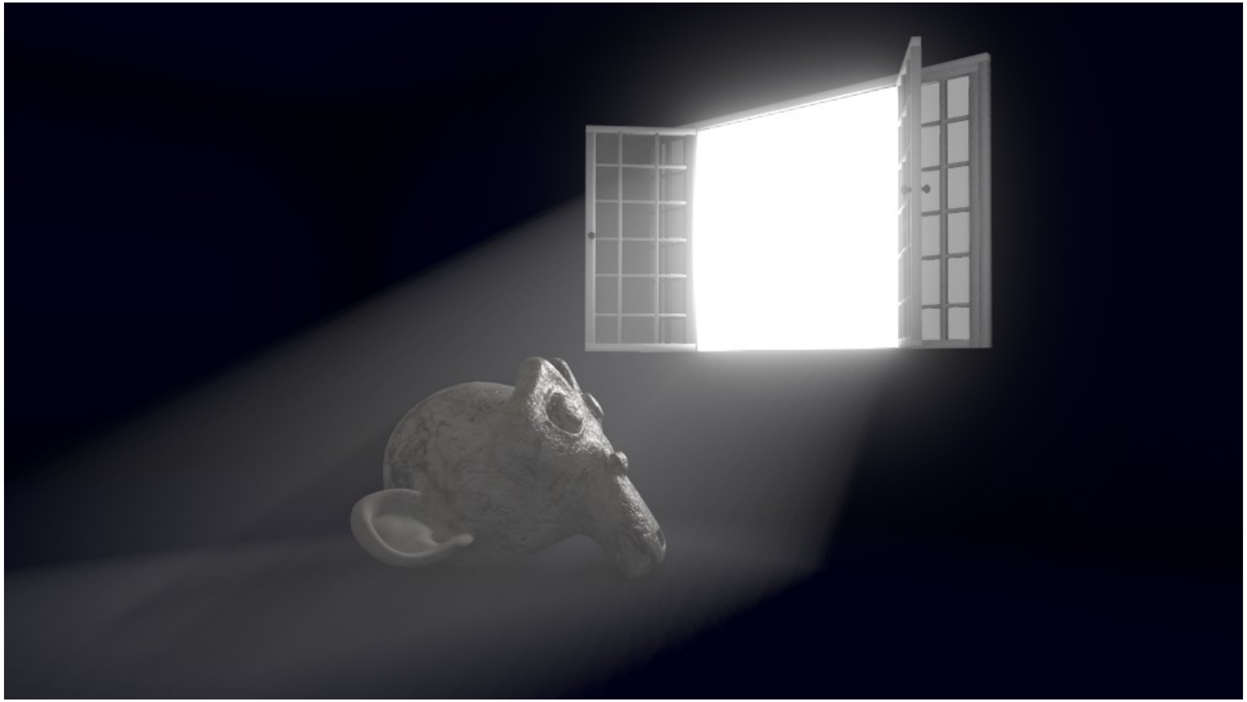




Monte Carlo



Importance Sampling



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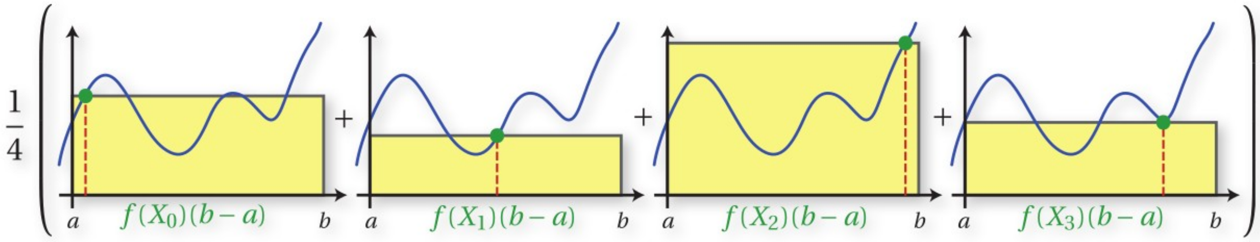
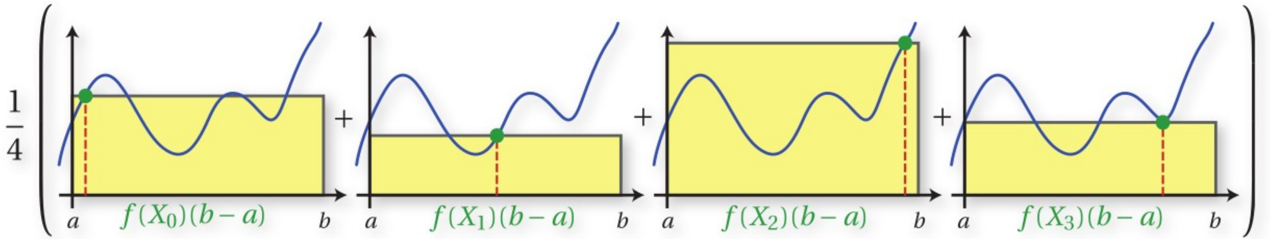
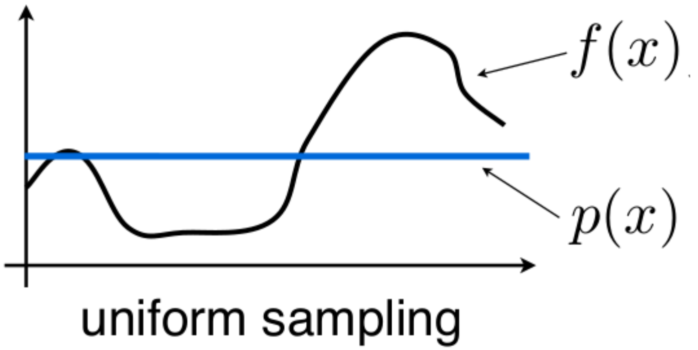
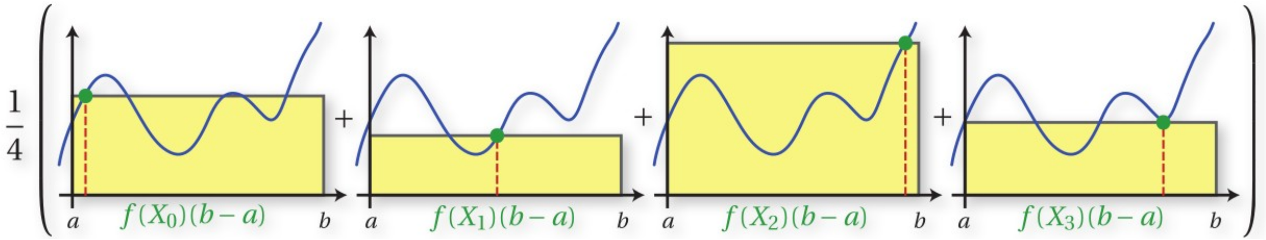


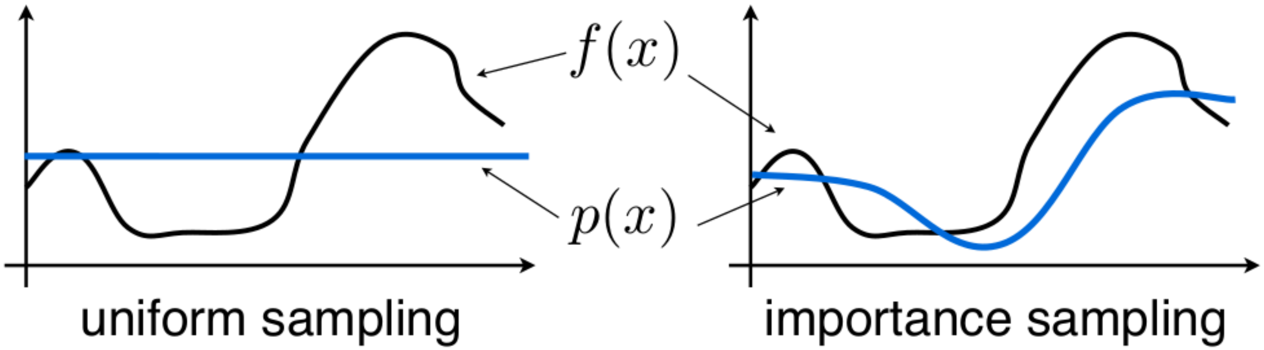
Importance Sampling



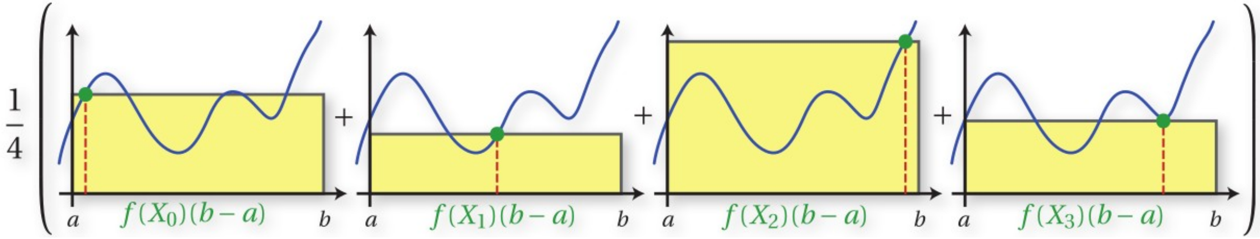


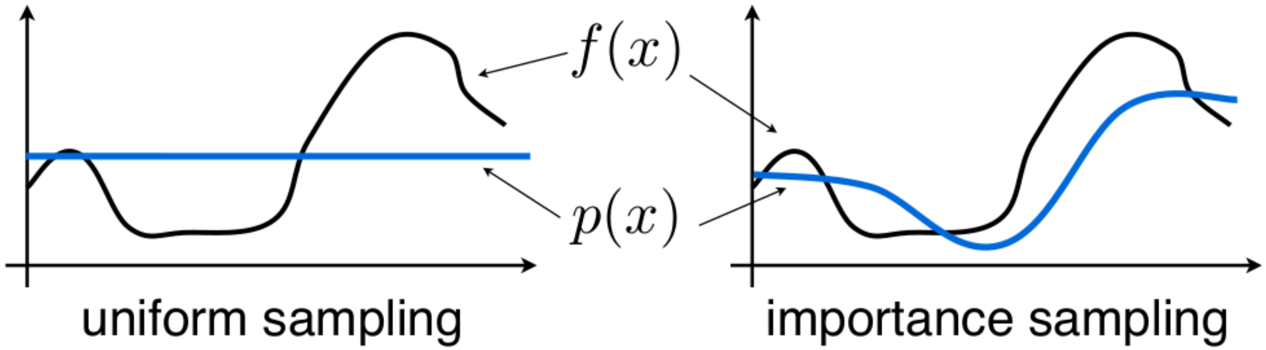
Importance Sampling





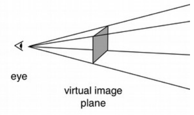
Importance Sampling





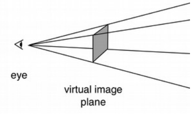
$$F_N = \frac{1}{N} \sum_{i=1}^{N} \frac{f(X_i)}{p(X_i)}$$

Woher kommt f?

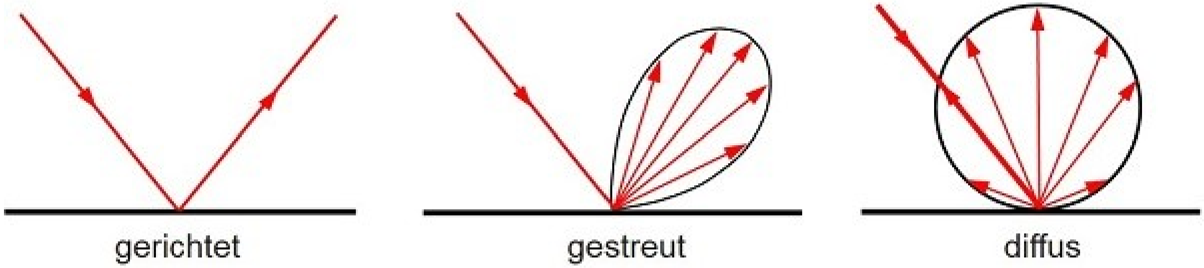


$$L_o(x,\omega_r) = L_e(x,\omega_r) + \int_{H^2} f_r(x,\omega_i,\omega_r) * L_i(x,\omega_i) * \cos(\theta_i)\, d\omega_i$$

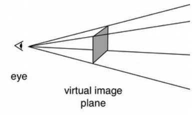
Woher kommt f?



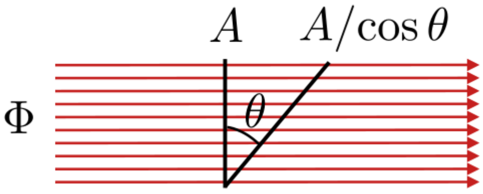
$$L_o(x,\omega_r) = L_e(x,\omega_r) + \int_{H^2} \boxed{f_r(x,\omega_i,\omega_r)} * L_i(x,\omega_i) * \cos(\theta_i)\, d\omega_i$$



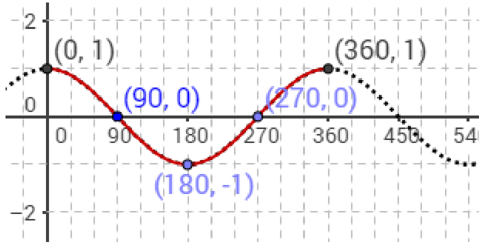
Woher kommt f?



$$L_o(x,\omega_r) = L_e(x,\omega_r) + \int_{H^2} f_r(x,\omega_i,\omega_r) * L_i(x,\omega_i) * \boxed{\cos(\theta_i)}\, d\omega_i$$

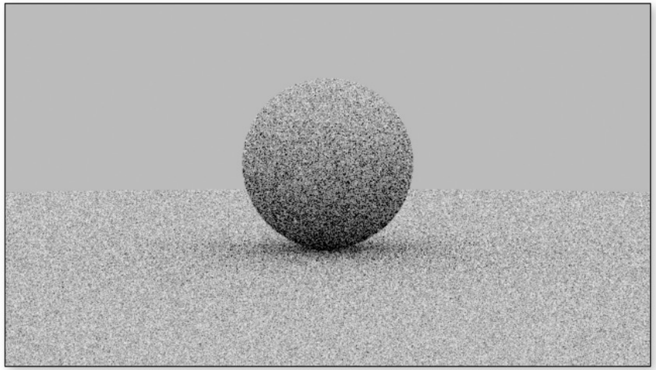


$$E = \frac{\Phi}{A/\cos\theta} = \frac{\Phi}{A}\cos\theta$$



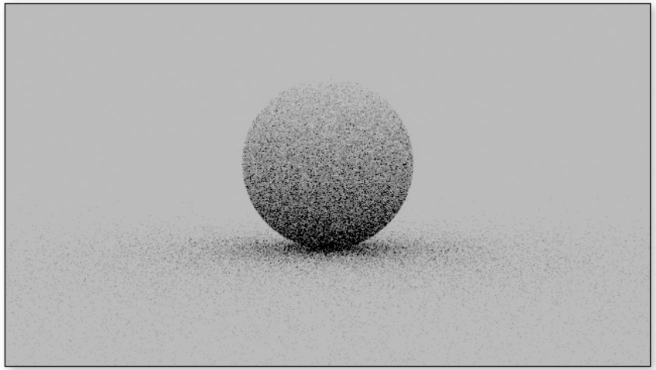
Importance Sampling

Uniform Hemispherical Sampling



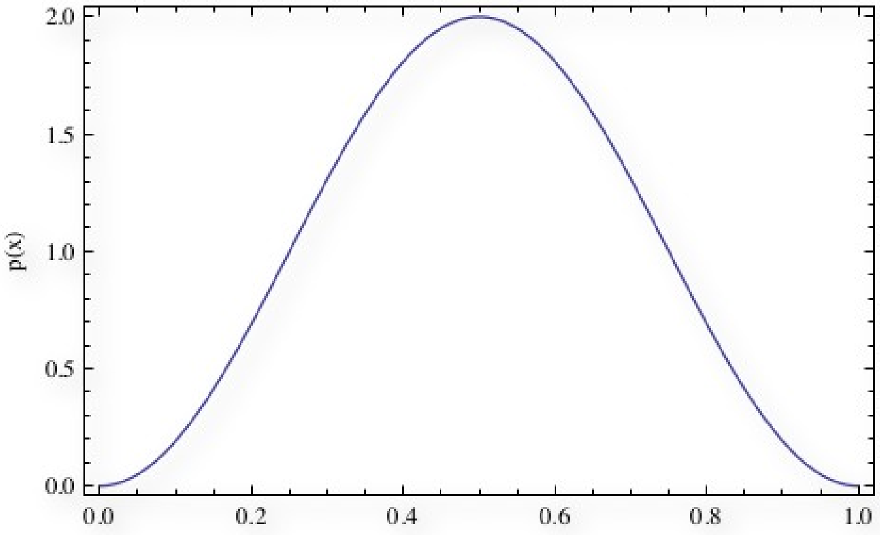
4 samples

Cosine-weighted Hemispherical Sampling



Ich habe mein $p(x)$. Wie Generiere ich Samples?

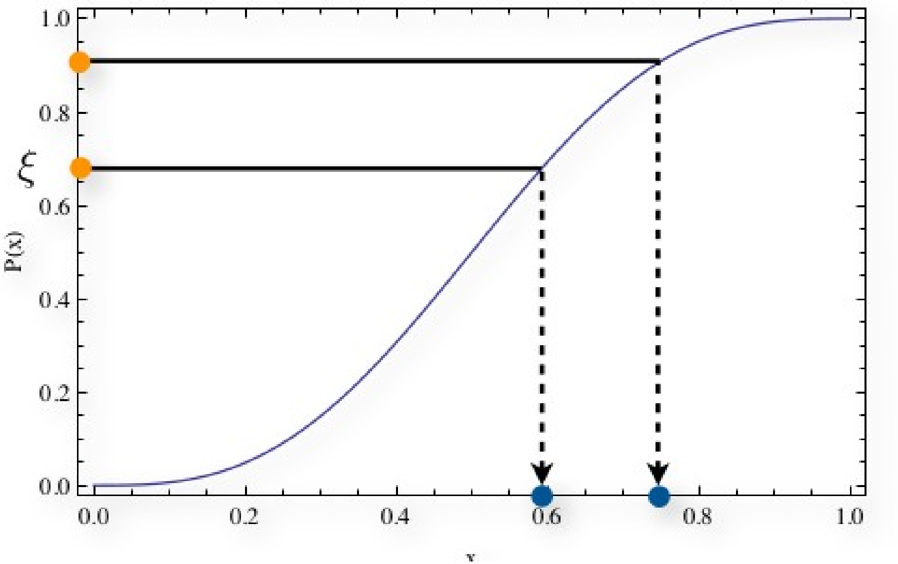
PDF



Probability Distribution Function

$$p(x) = P[\xi = x]$$

CDF

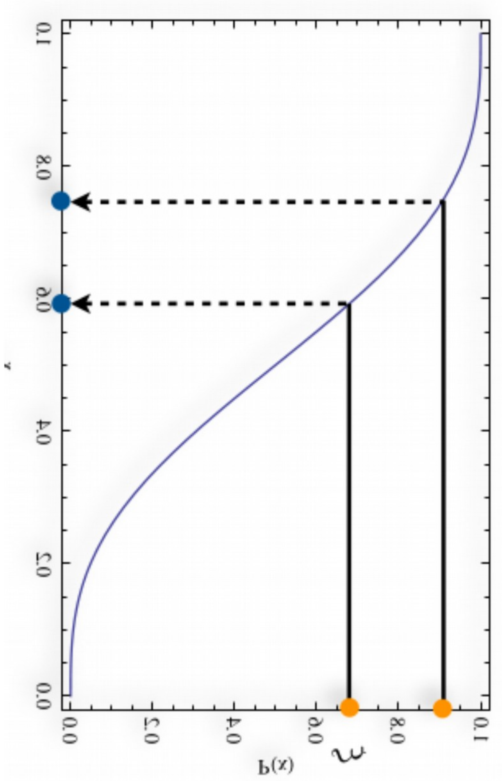


Cumulative Distribution Function

$$P(x) = P[\xi <= x]$$

$$= \int_0^x p(x')\,dx'$$

CDF^{-1}

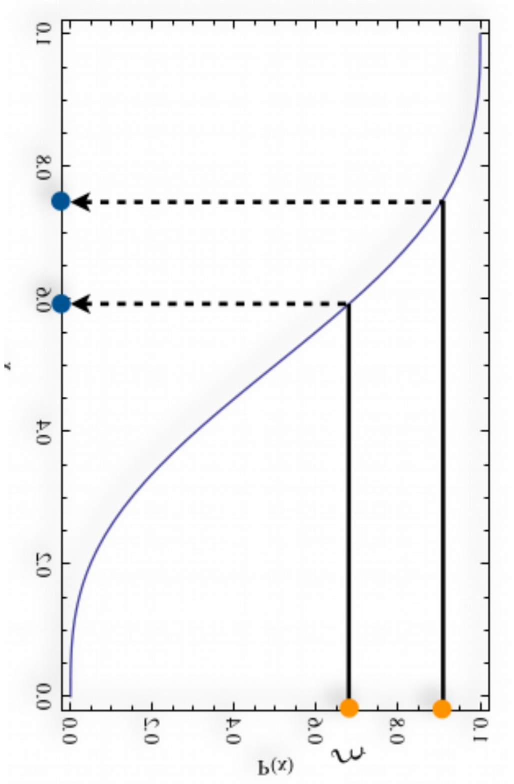


Invserse $P^{-1}(\xi)$

Generiere ξ uniform zufällig

Sample $X_i = P^{-1}(\xi)$

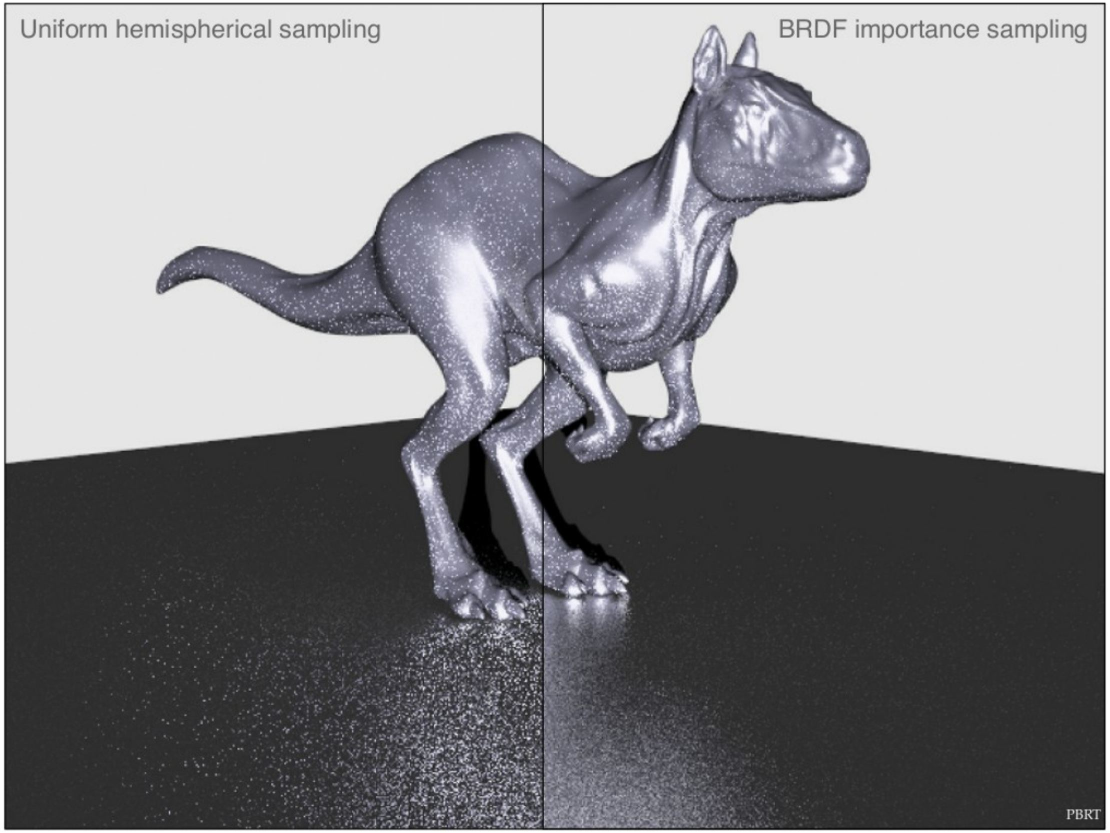
CDF^{-1}



Wahrscheinlichkeit von X_i:

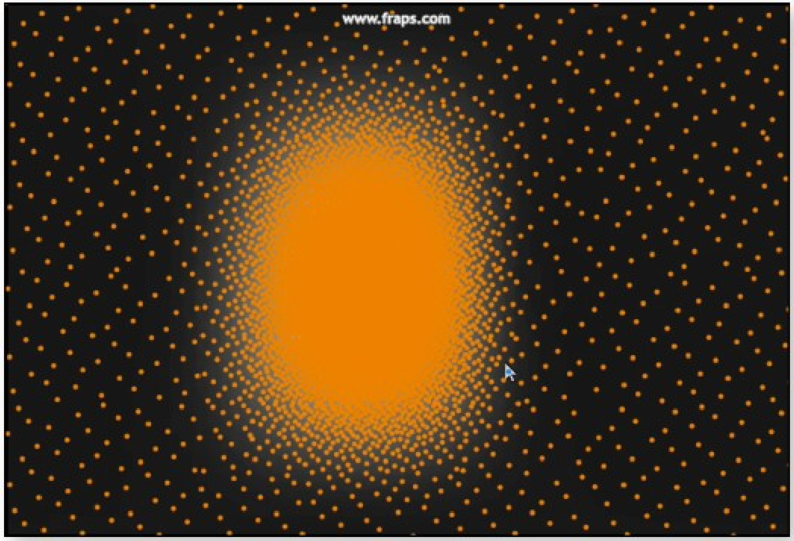
$p(X_i)$

Importance Sampling



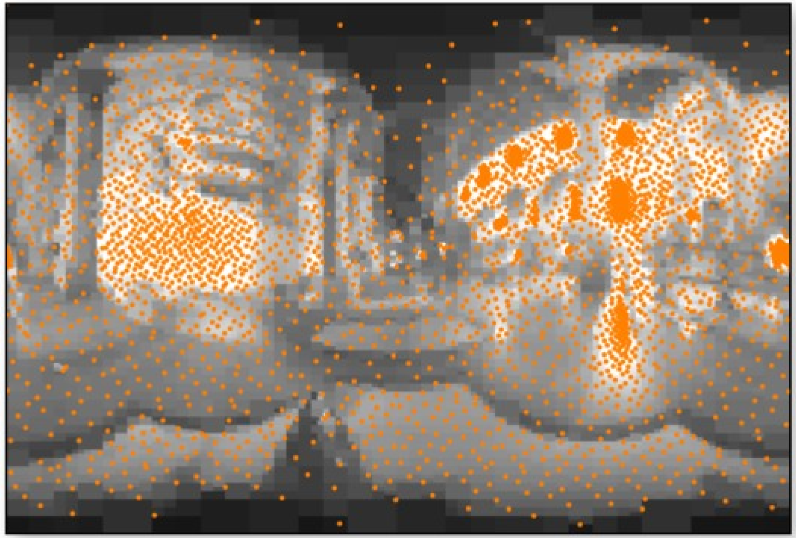
Environment Map

Importance Sampling



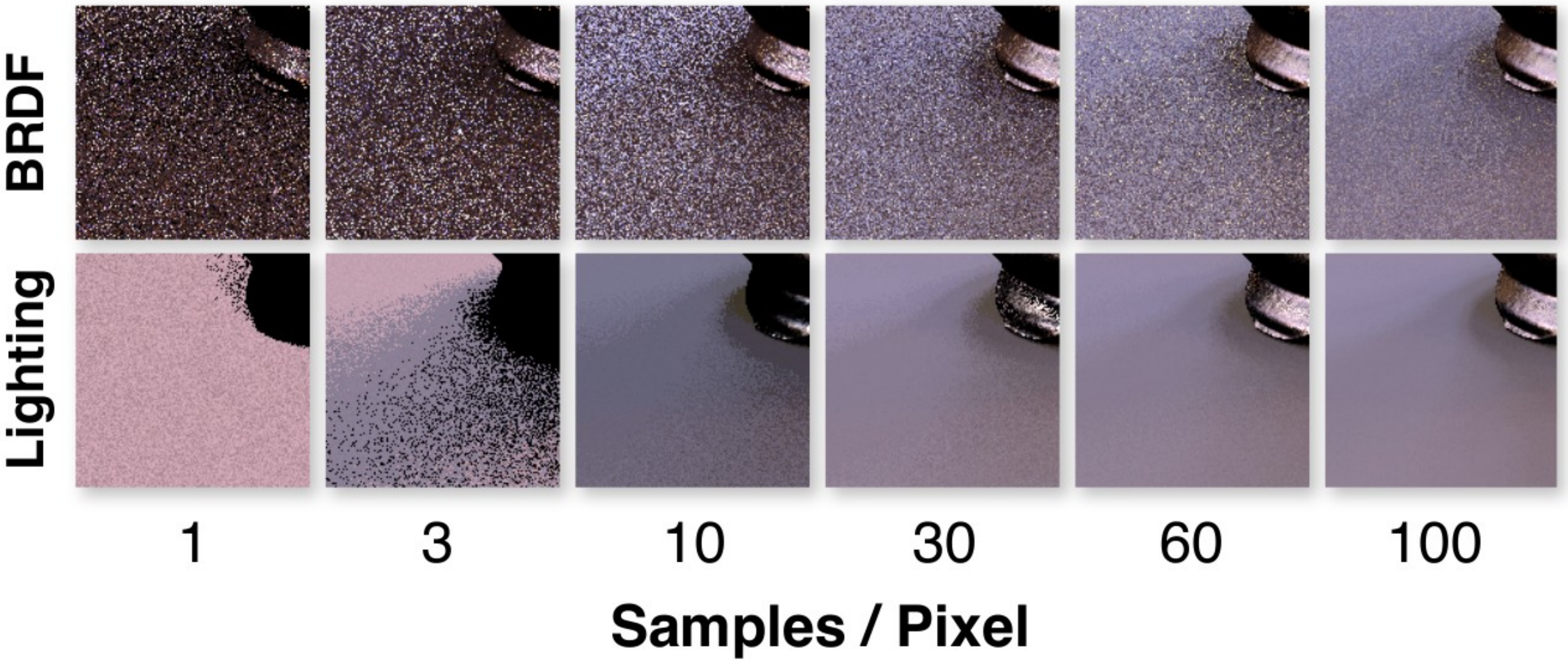
BRDF

or



Lighting

Importance Sampling



Ergebnisse

Ergebnisse

Ergebnisse