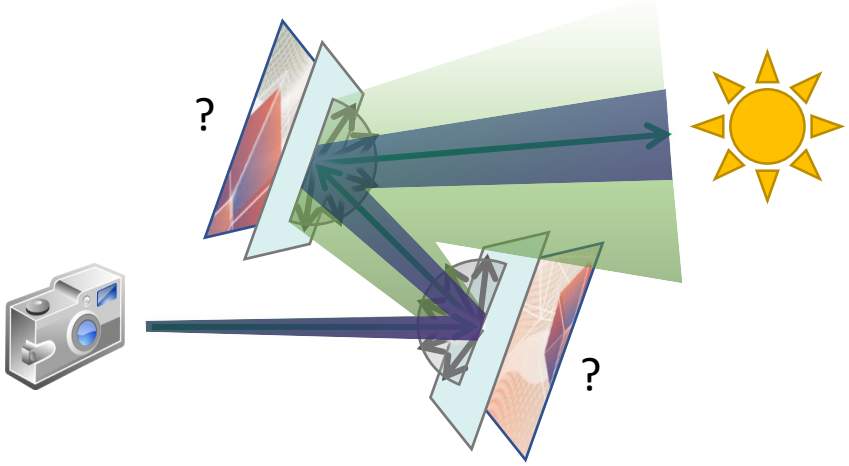
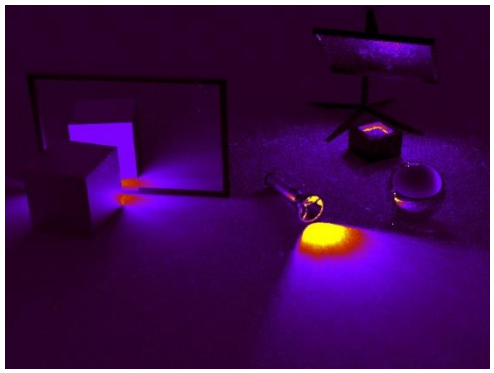




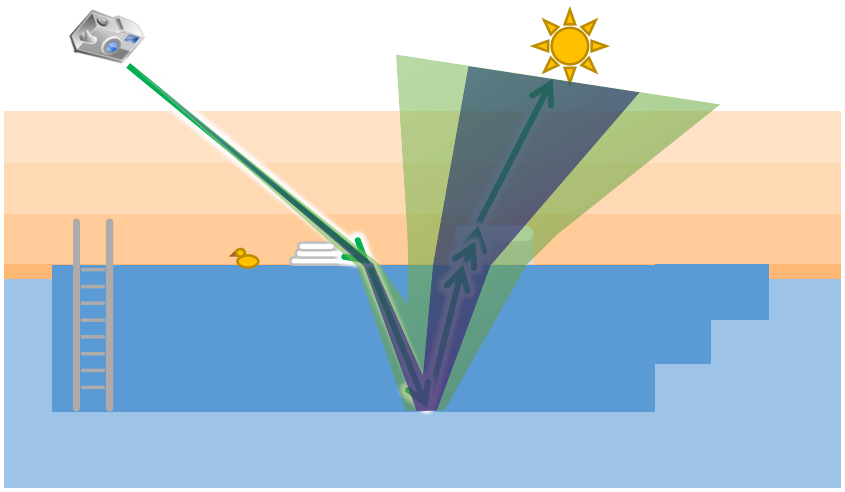
RESEARCH-ARTICLE

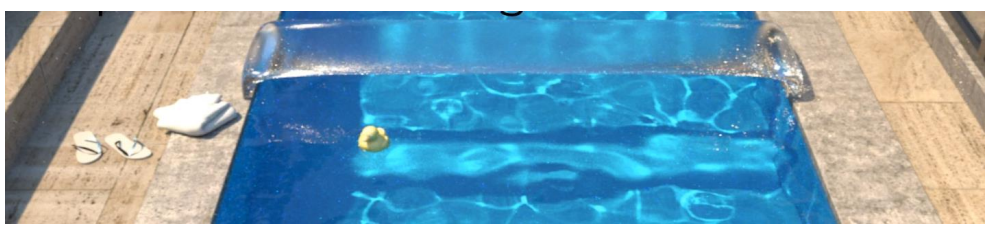
Path differential-informed stratified MCMC and adaptive forward path sampling

Explained

Authors: Tobias Zirr, Carsten Dachsb

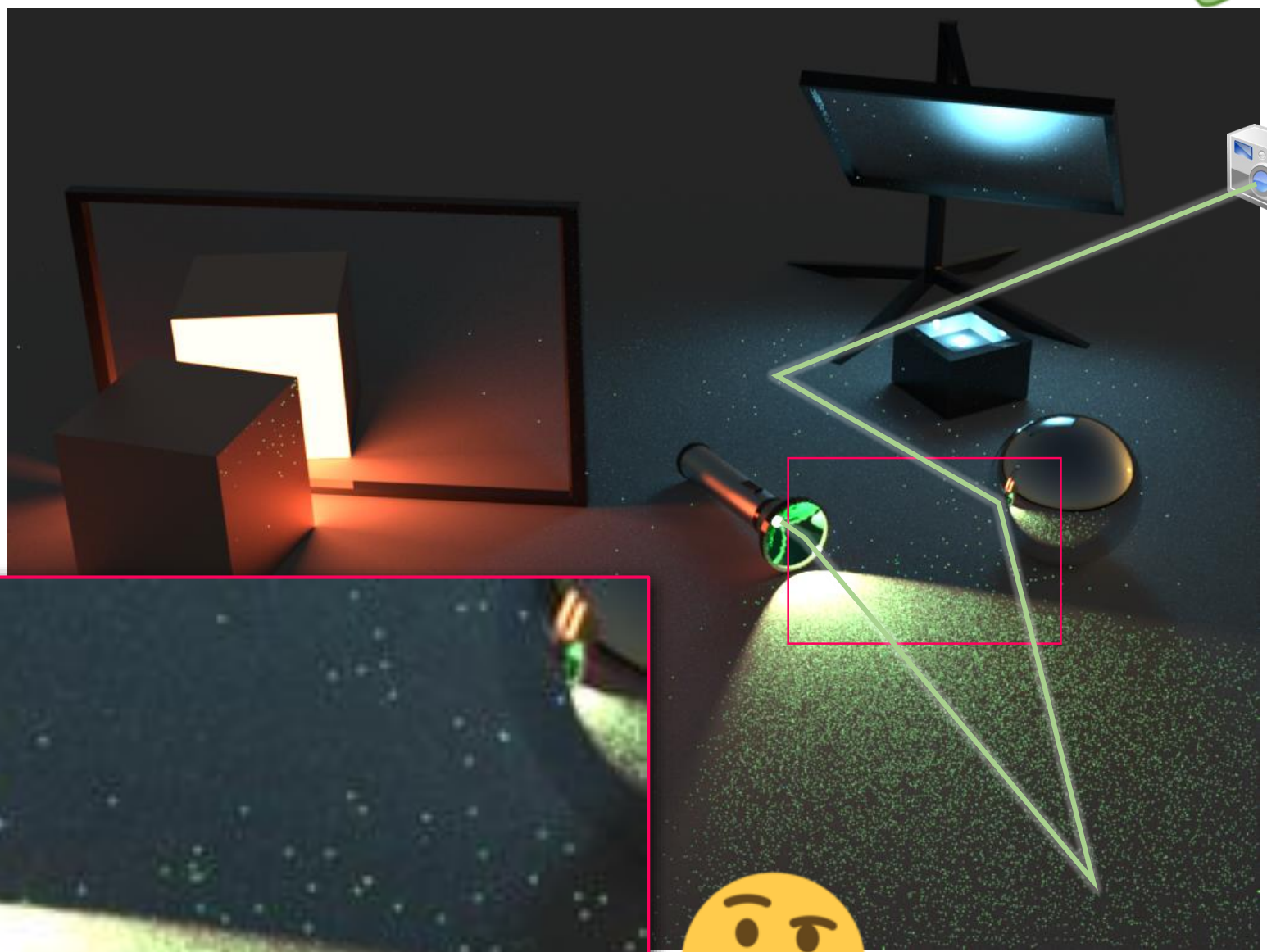
Publication: ACM Transactions on Graphics • November 2020 • Article No.: 246 • https://doi.org/10.1145/3414685.3417856

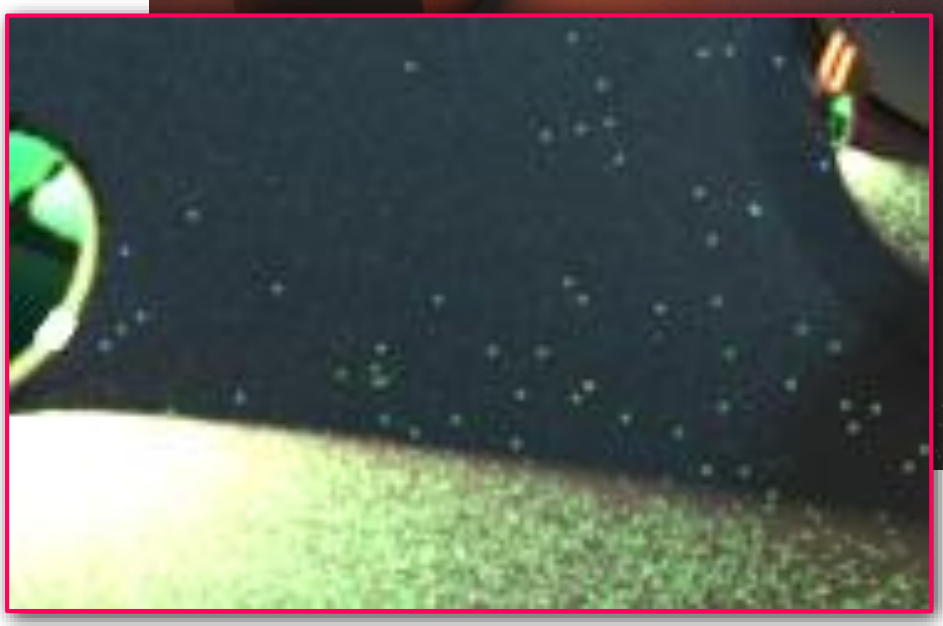




Why adaptive sampling?

Let’s render an image tracing 10.000 random light paths for each pixel!

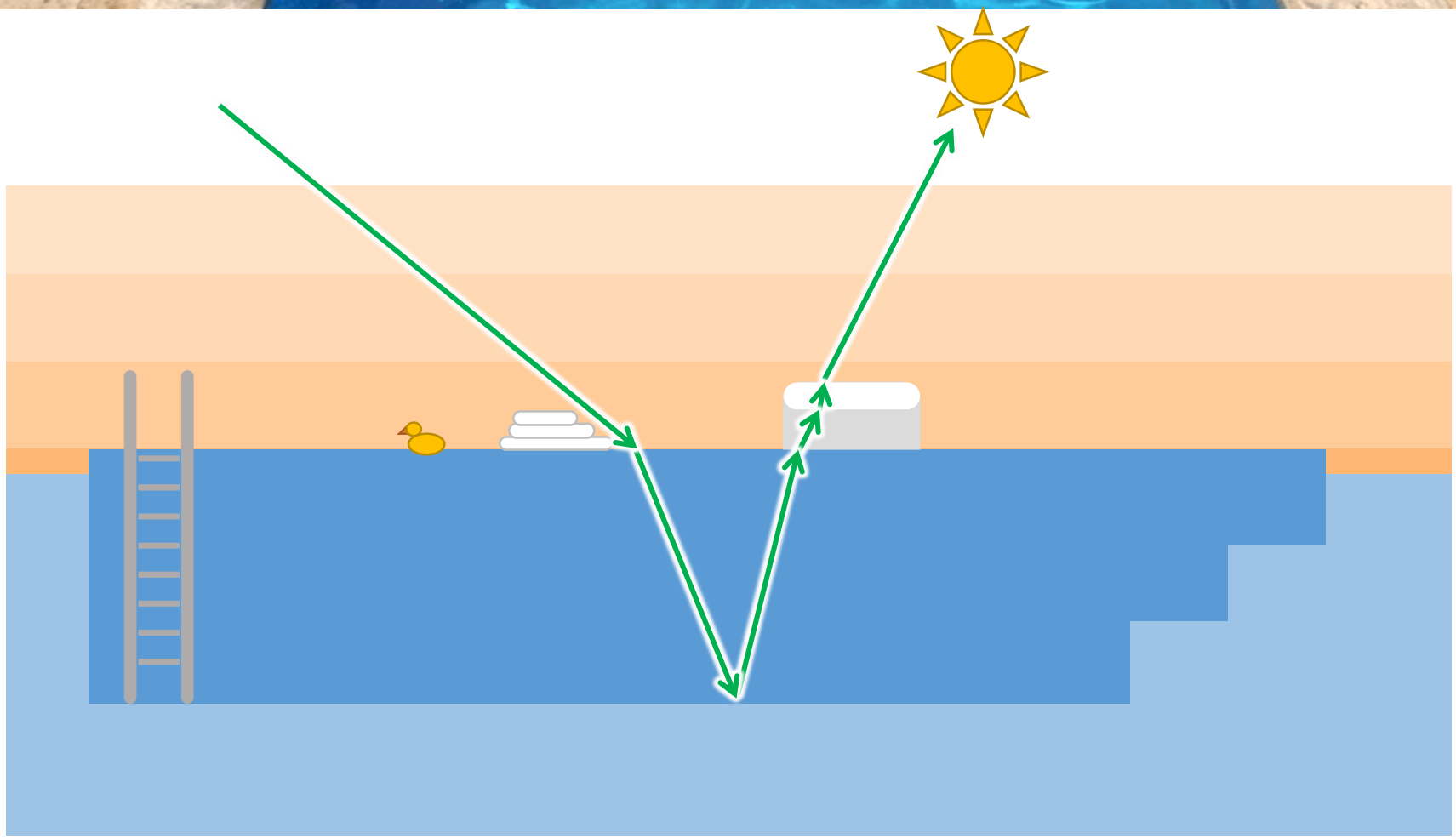




Not pretty

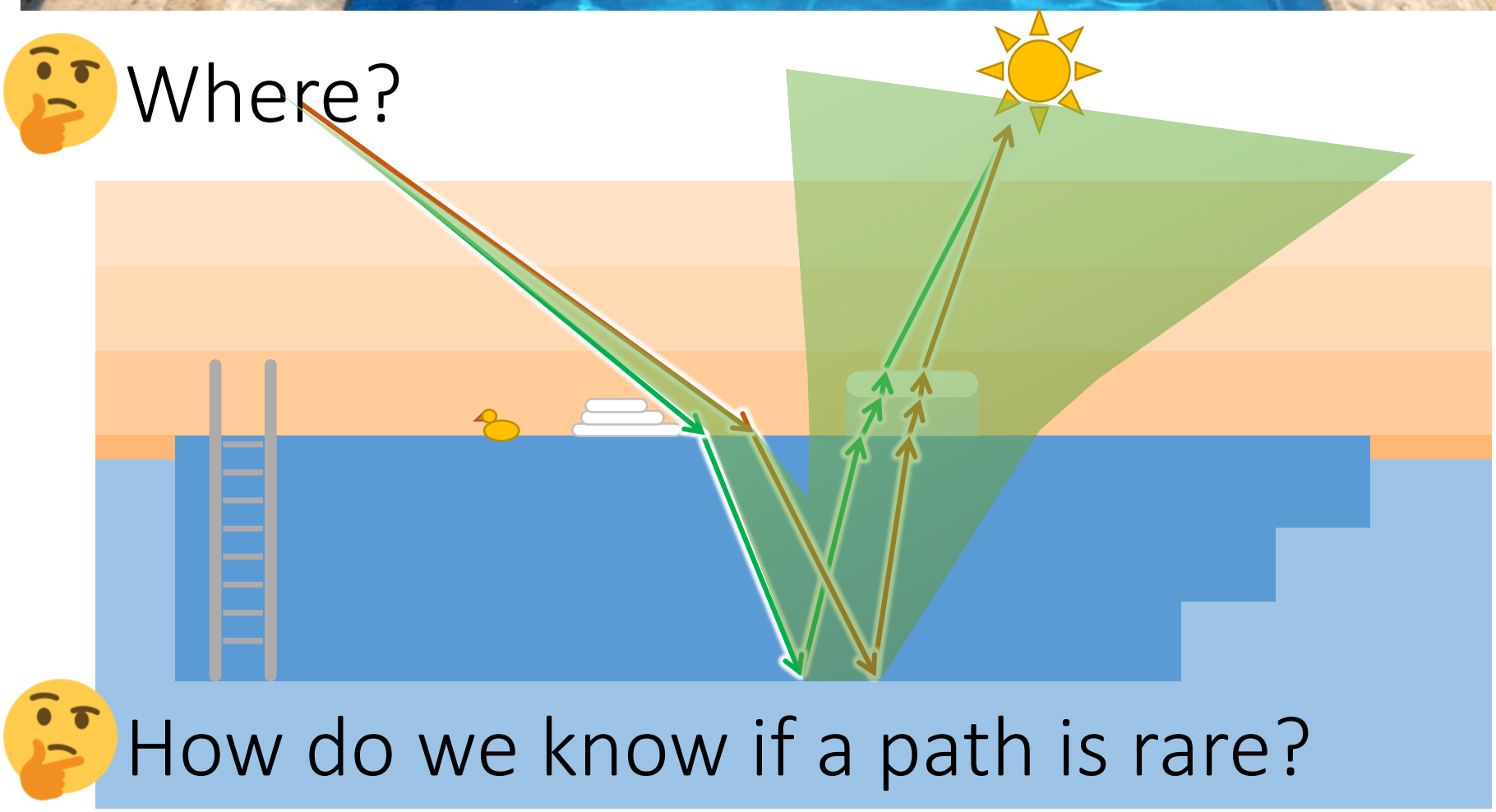
Some important light paths are rarely found by chance!

Often, those making pretty caustics



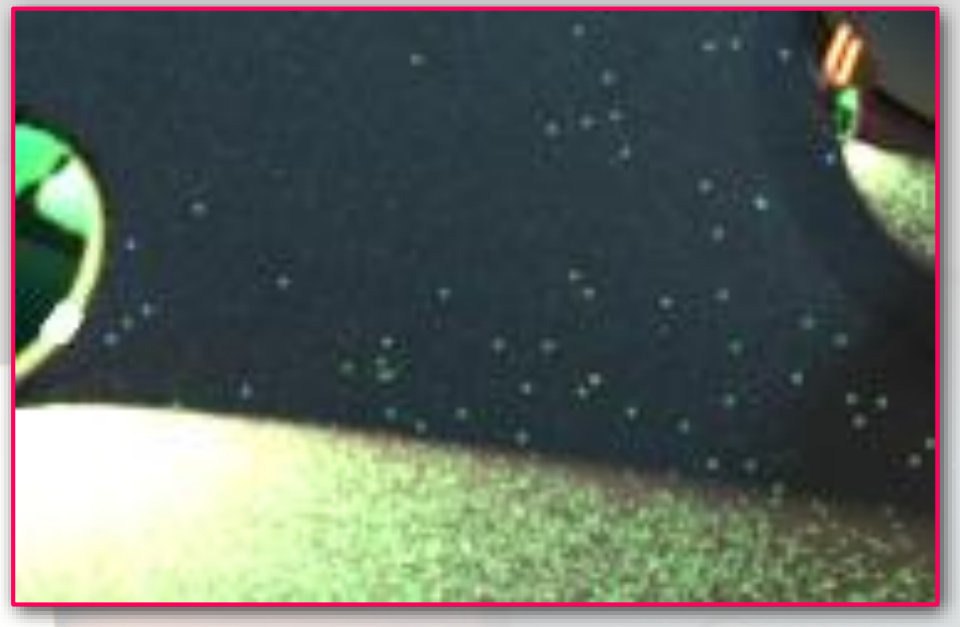
Let’s sample adaptively!

When rare light paths are found, we can try to look for more, similar paths



When is a path rare but important?

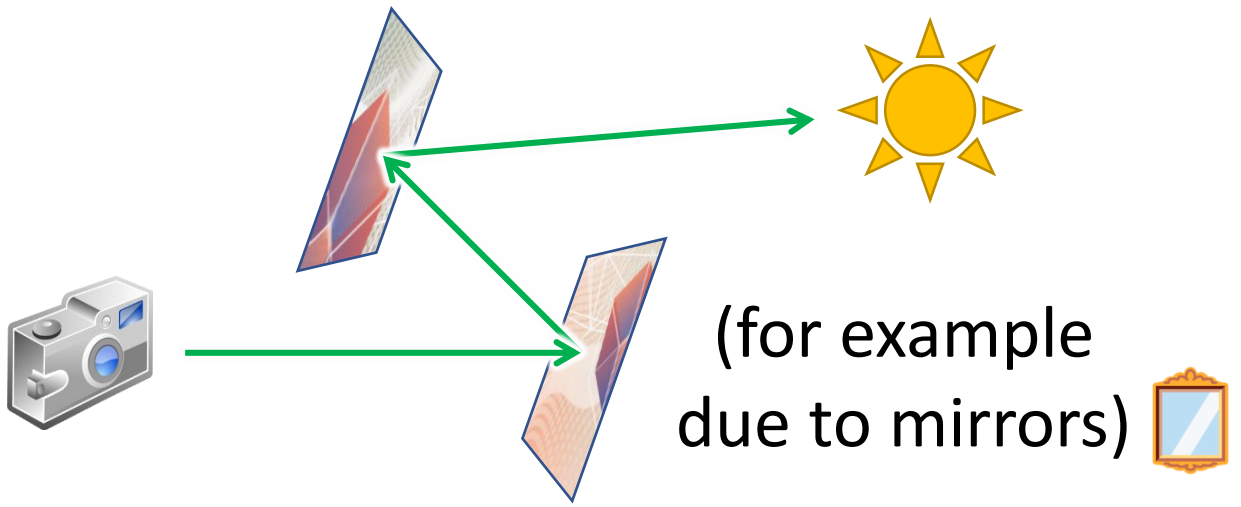
Its contribution is unusually bright!



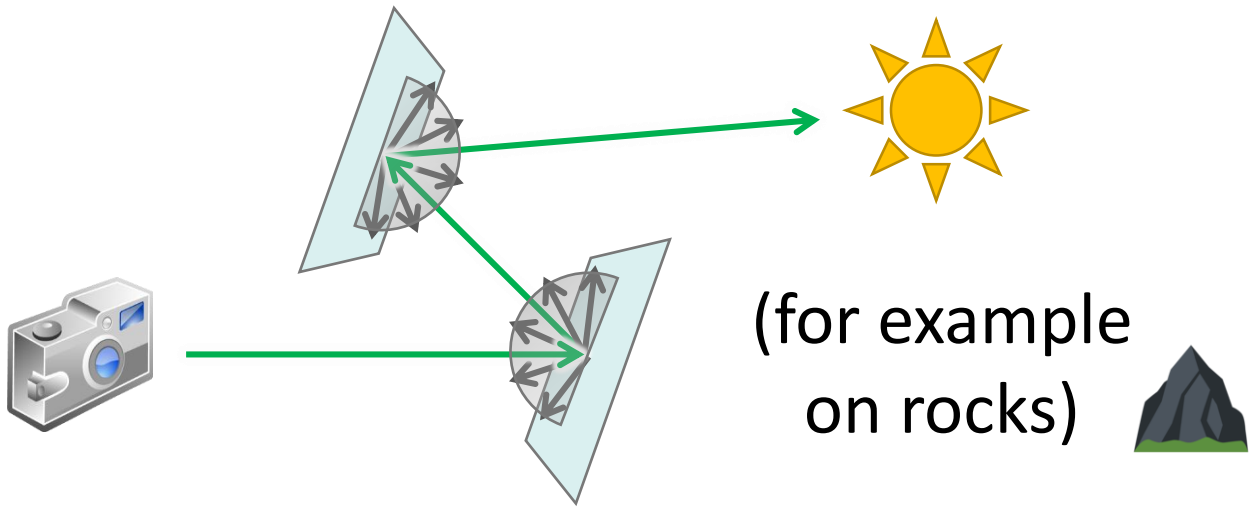
But simple lights are also bright!

In addition to brightness, let us check how widely paths are scattered! 🧐

Some paths are easy to find, because they all go into the same directions:

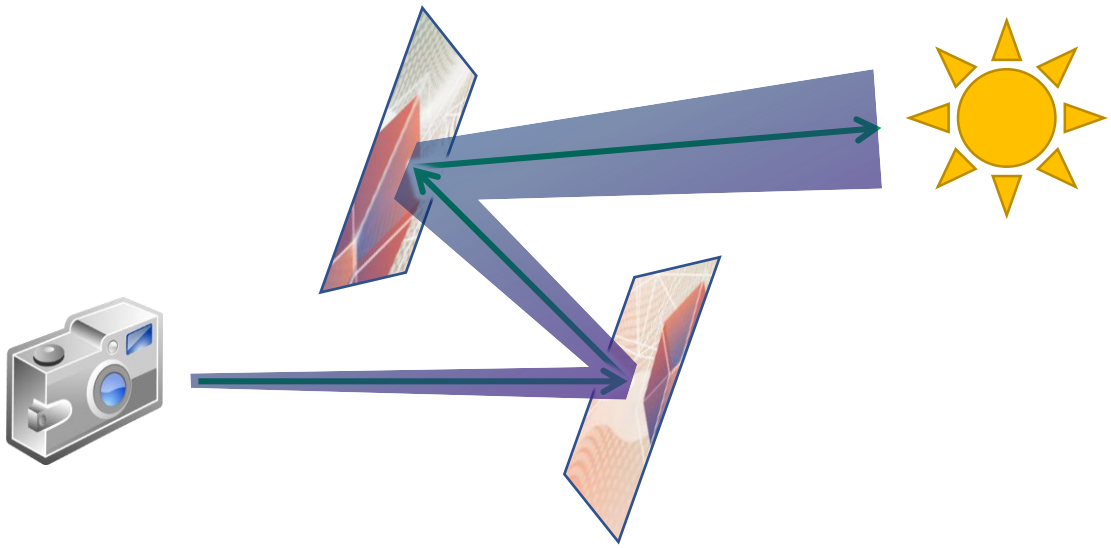


Other paths are scattered into all kinds of directions:

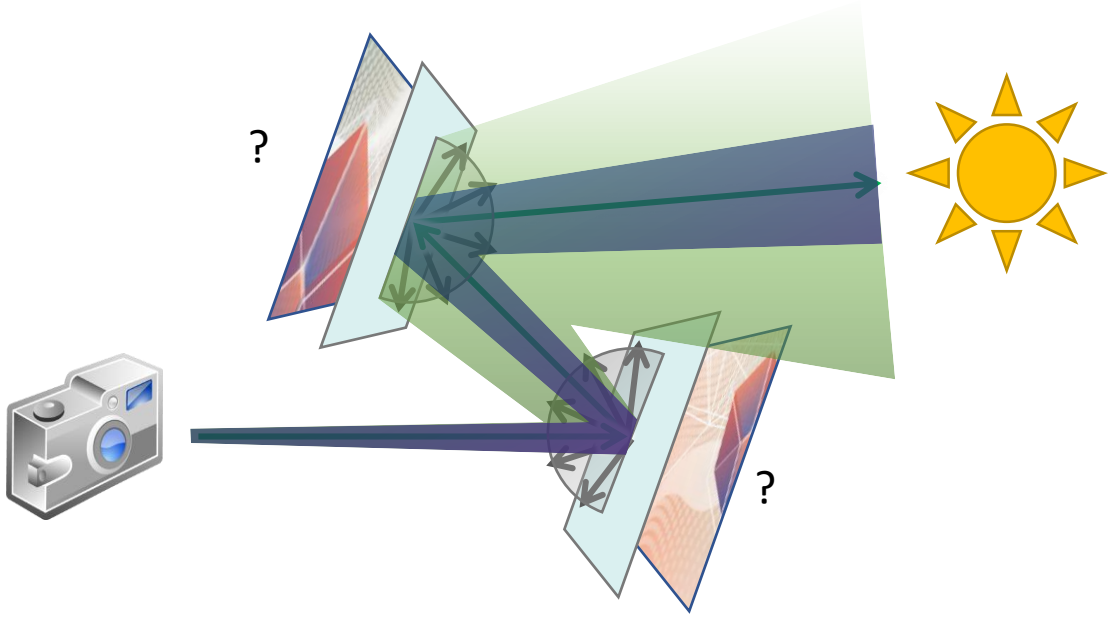


We find that it is enough to know how a small set of paths is scattered

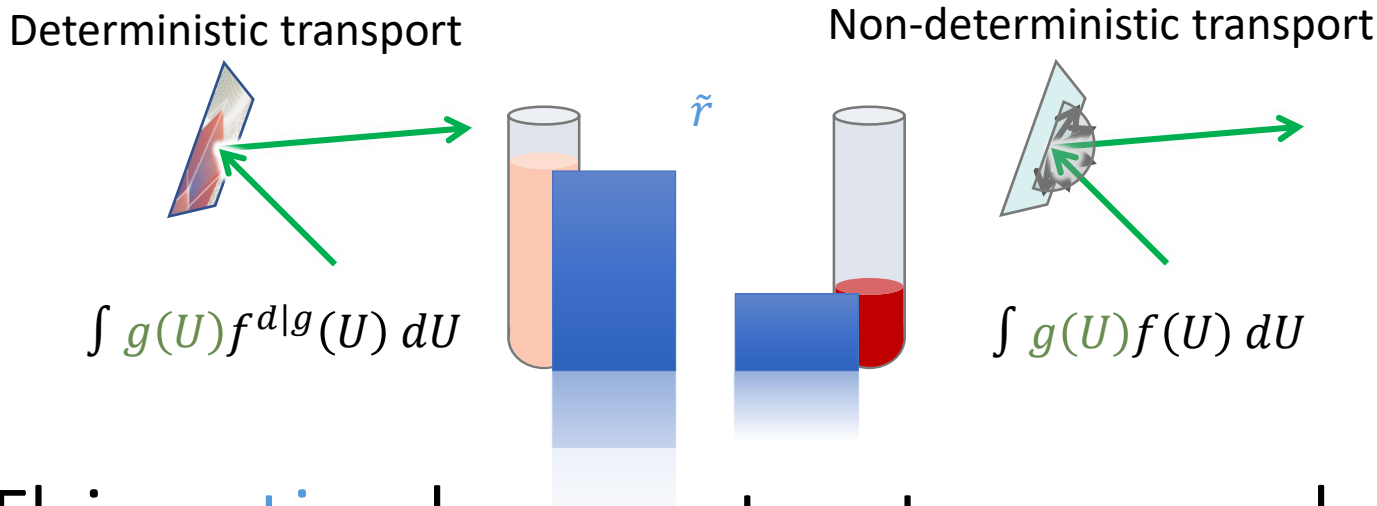
… comparing paths we find easily …



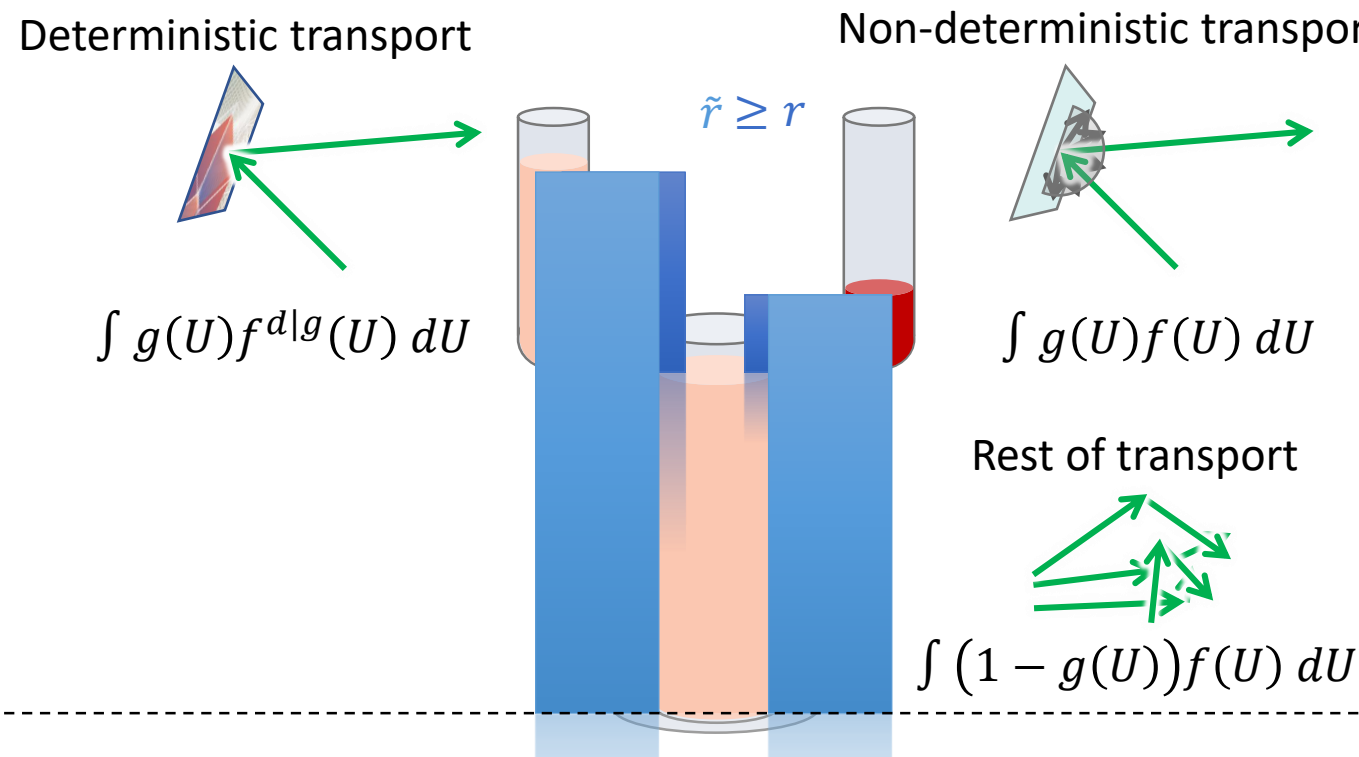
… to paths we find rarely …



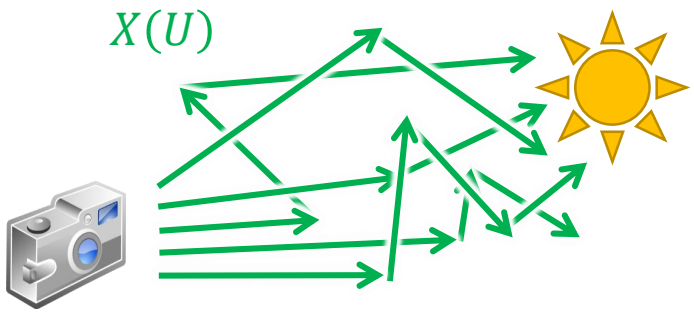
We compute the brightness of paths in a region as if they were easy to find, compared to the actual scattering

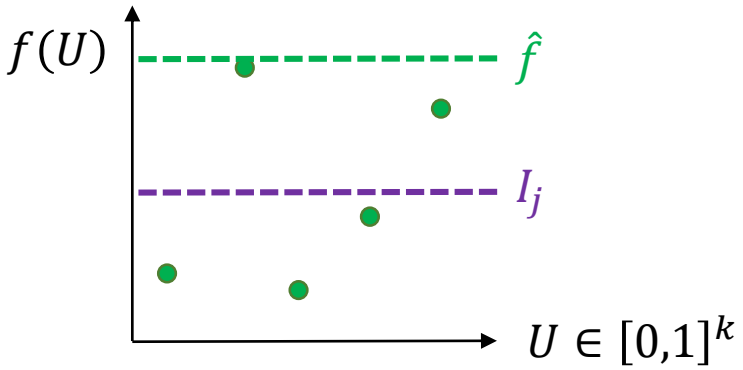


This ratio does not get worse when we include paths outside the region!



With our ratio, we can bound potential pixel error in terms of the differential environment of individual paths!





Integral:

$$I_j = \int f(U)\, dU$$

Variance:

$$\mathbf{V}[f(U)] = \int f^2(U)\, dU$$

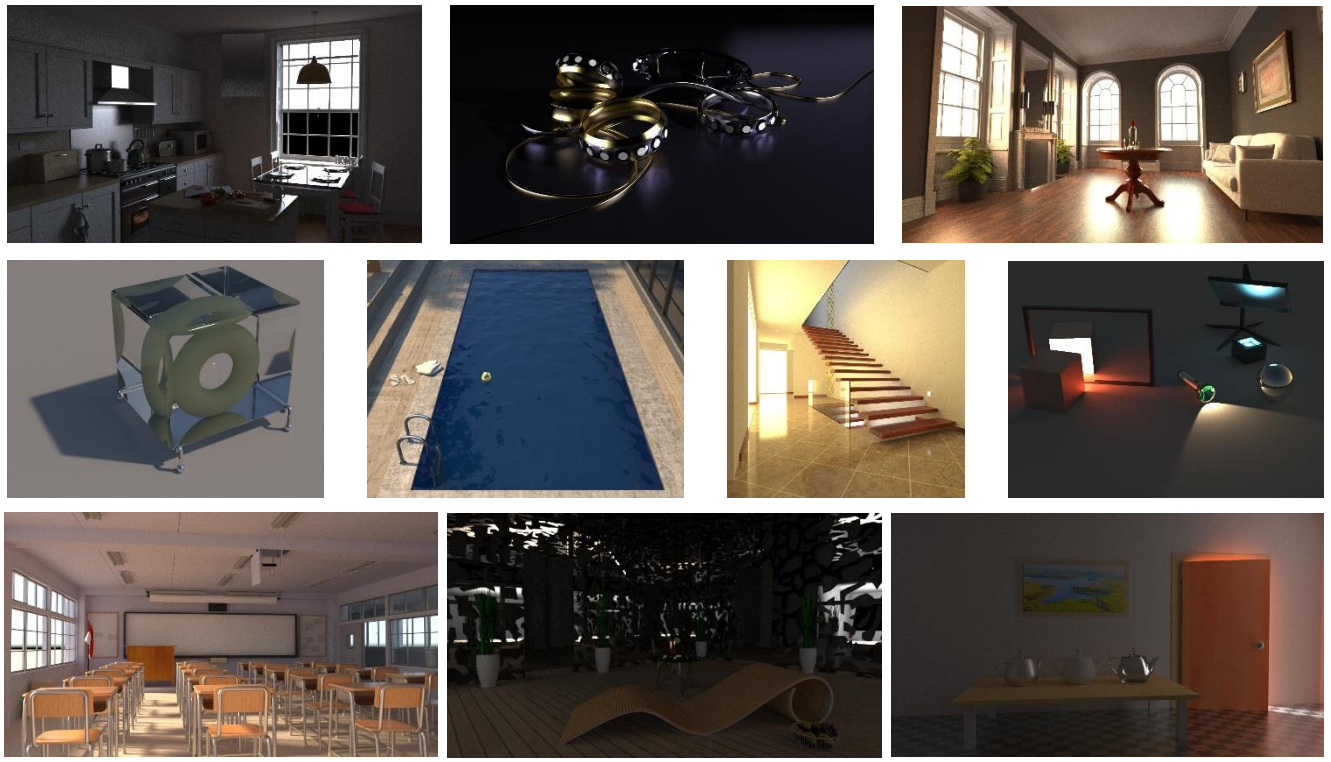
Relative Variance:

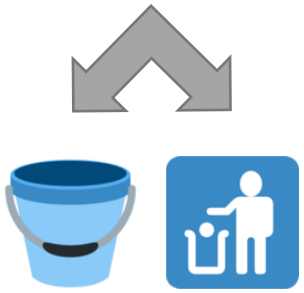
$$\frac{\mathbf{V}}{I_j^2} \leq \frac{\hat{f}}{I_j} = r\frac{\hat{f}}{I_j^{d|g}} \leq \tilde{r}\frac{\hat{f}}{I_j^{d|g}}$$

Of course, we cannot anticipate the complexity of entire scenes from one path. The error is bounded compared to an unknown, but usually good error of alternative simpler scenarios.

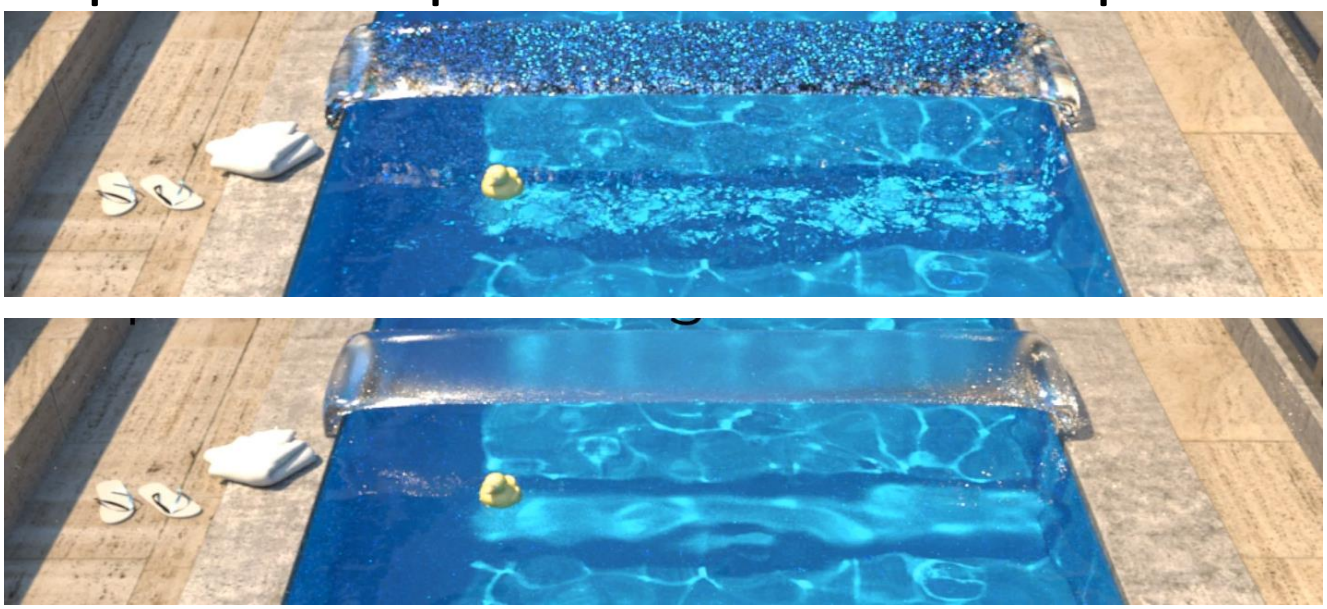
What can we do with it?

Separate good paths from bad paths:



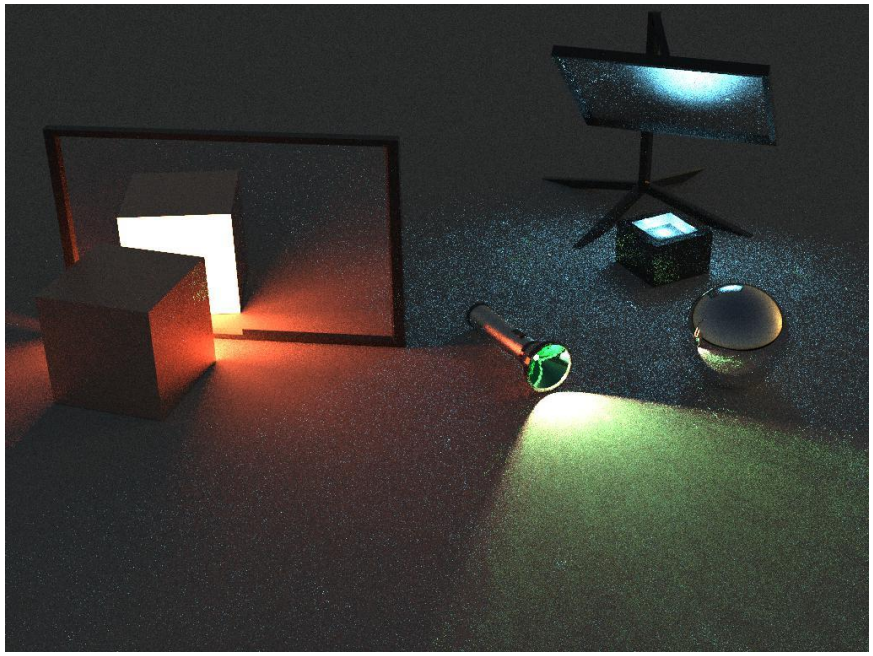


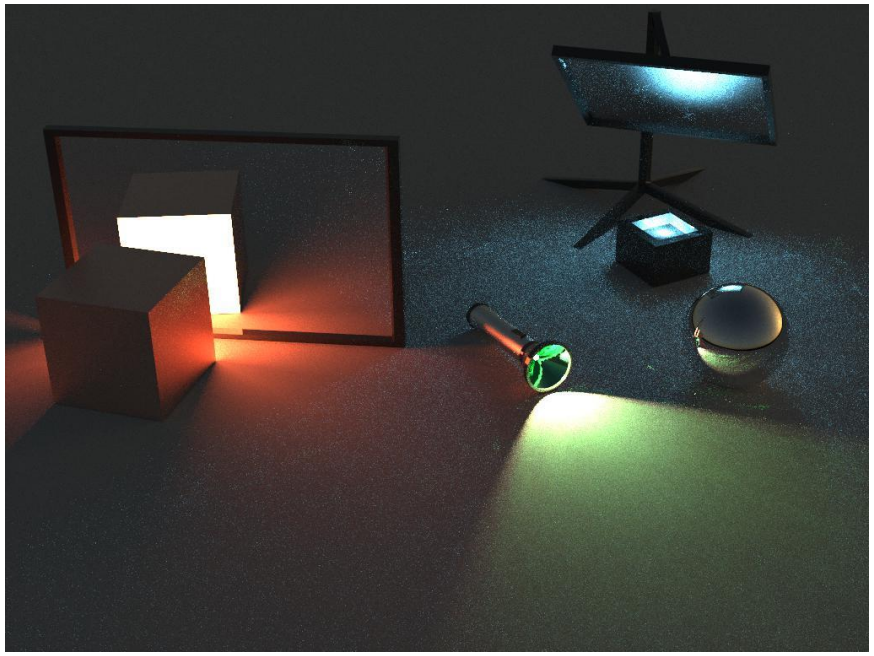
Sample bad paths more adaptively:



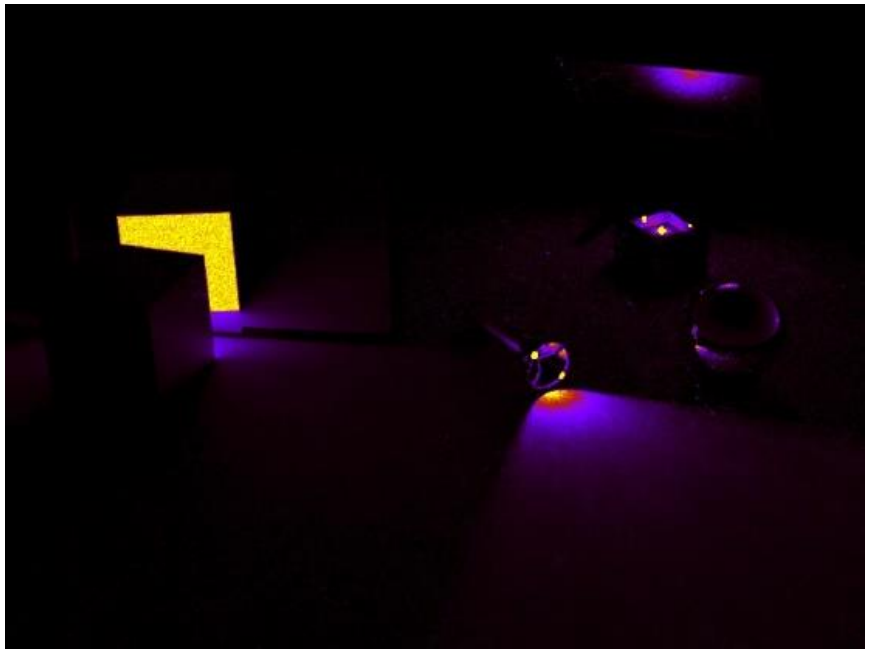
What can we do with it?

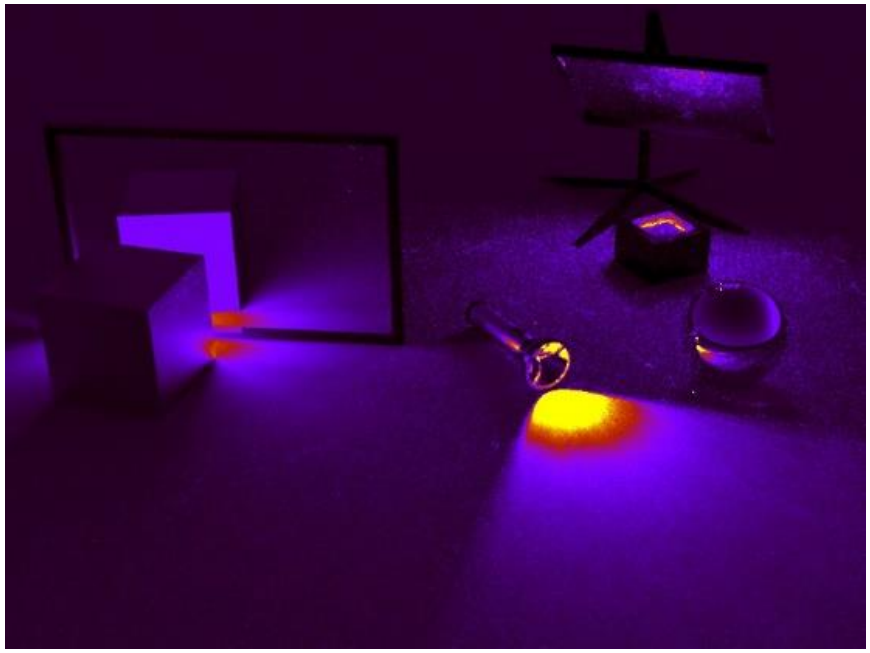
Put samples where we want them … 👈



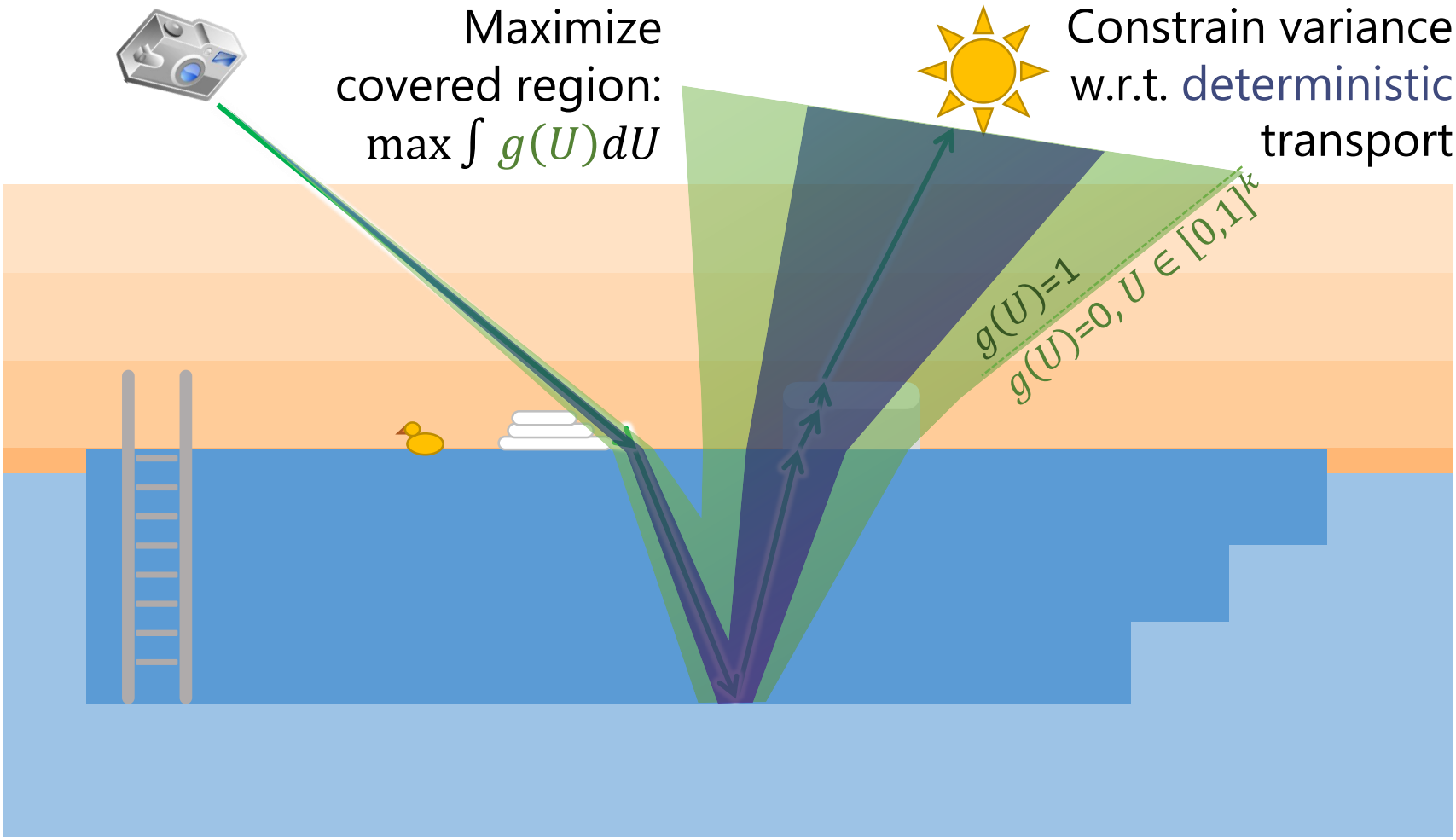


… i.e. put less samples on easy paths 📊



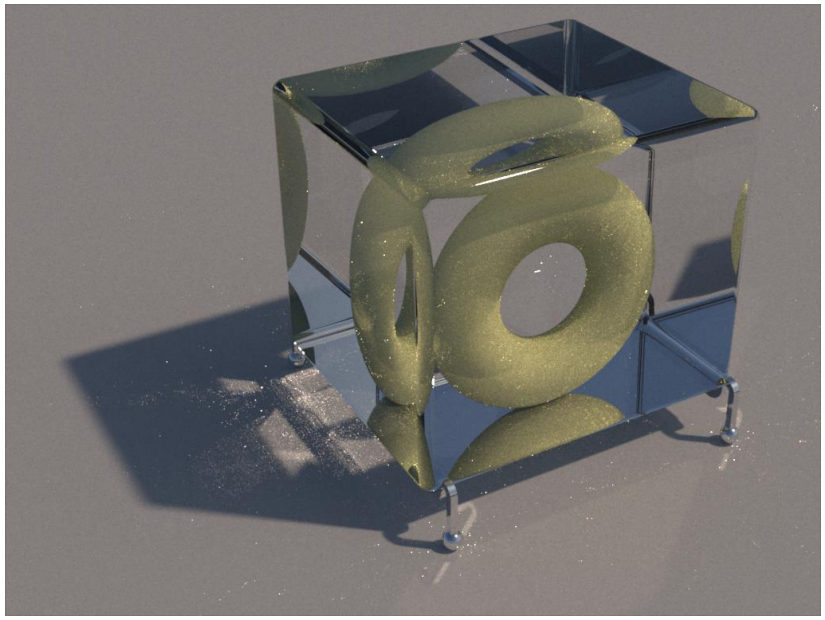


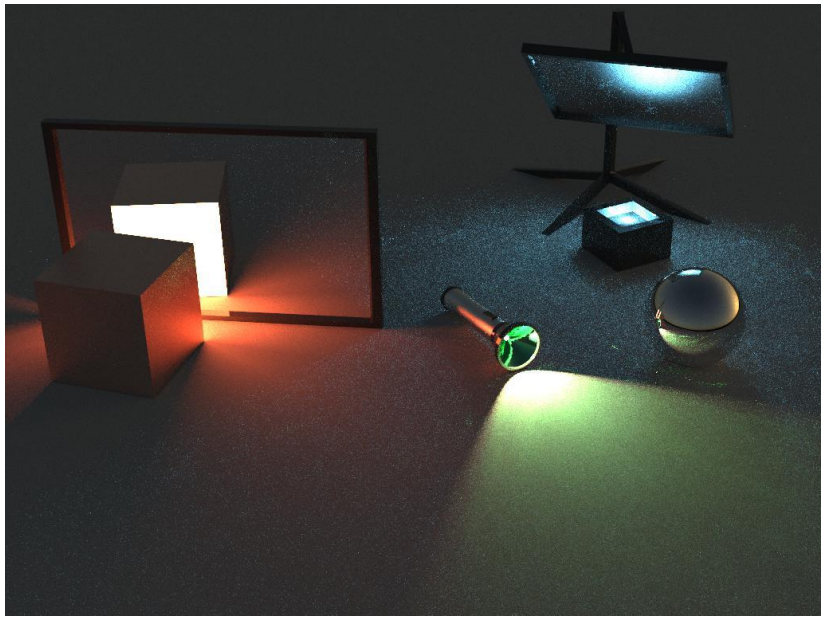
When I find a rare path, where do I look for more useful paths?

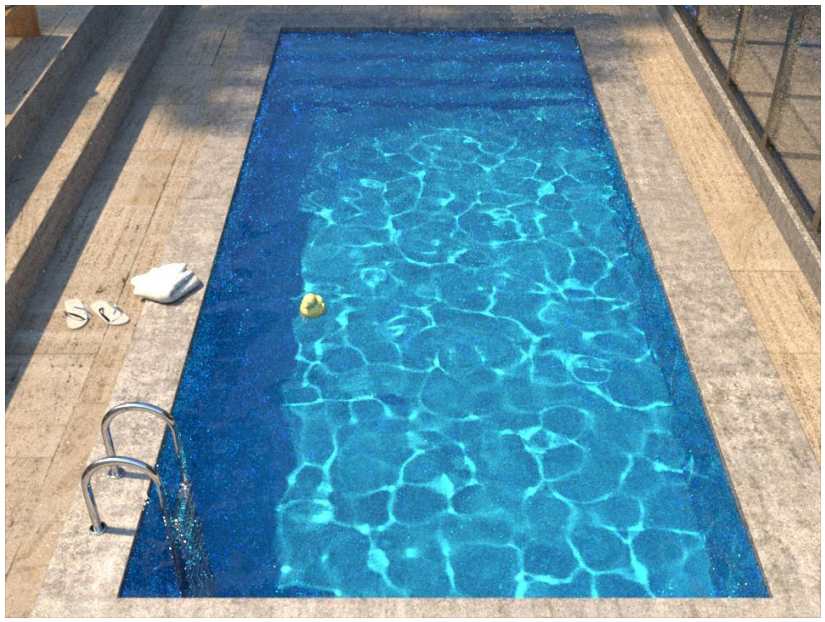


Using our previously computed subset ratios, that is a simple constrained optimization problem (KKT)!

Even simple methods, like path tracing from the camera, can give nice results with good adaptive sampling regions







https://cg.ivd.kit.edu/pathdiff-mc.php

More details in the paper, talk & code!

Contact: tobias.zirr@alphanew.net