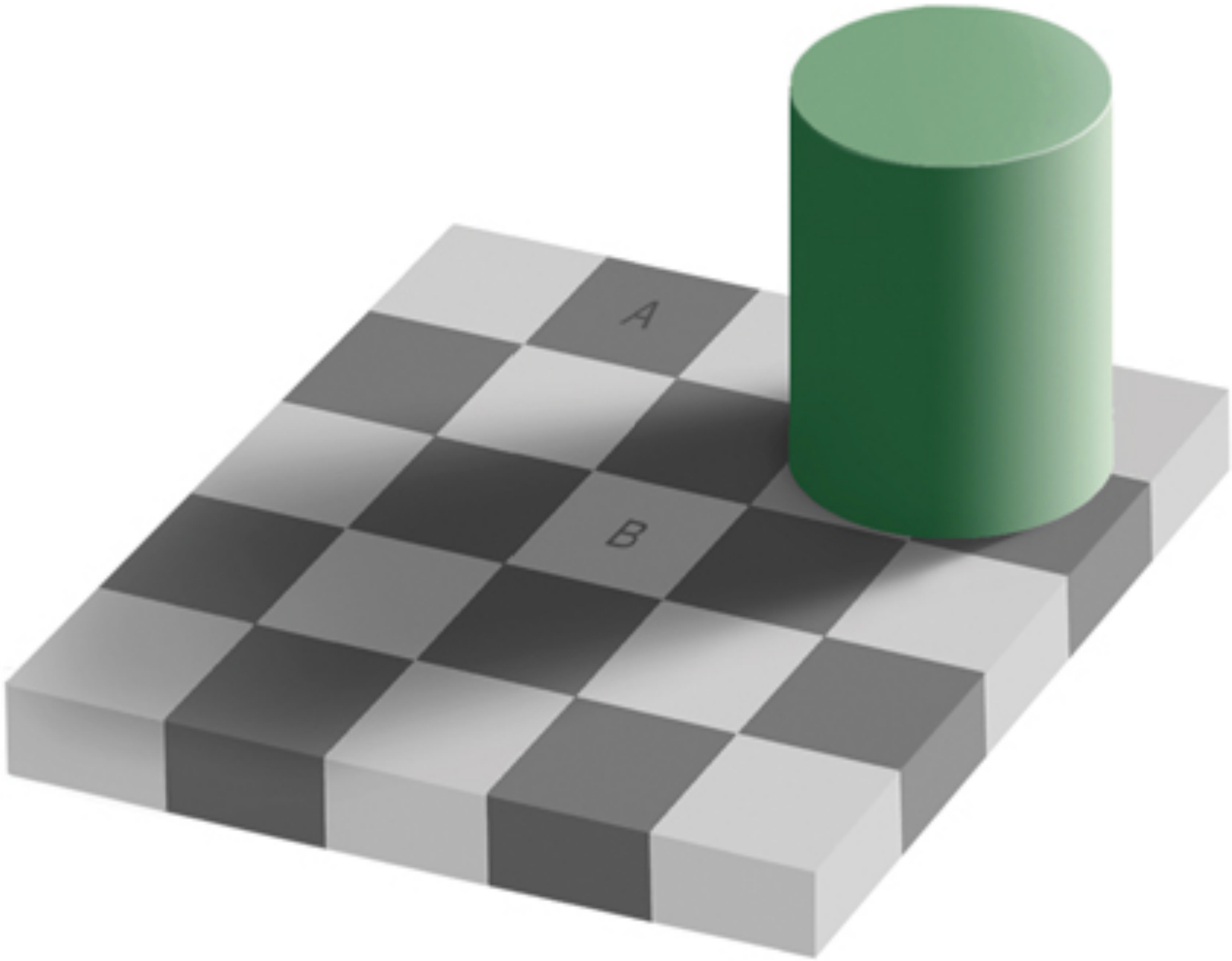
Visual Computing: Blending (Poisson & Graph Cut)

SS 2016

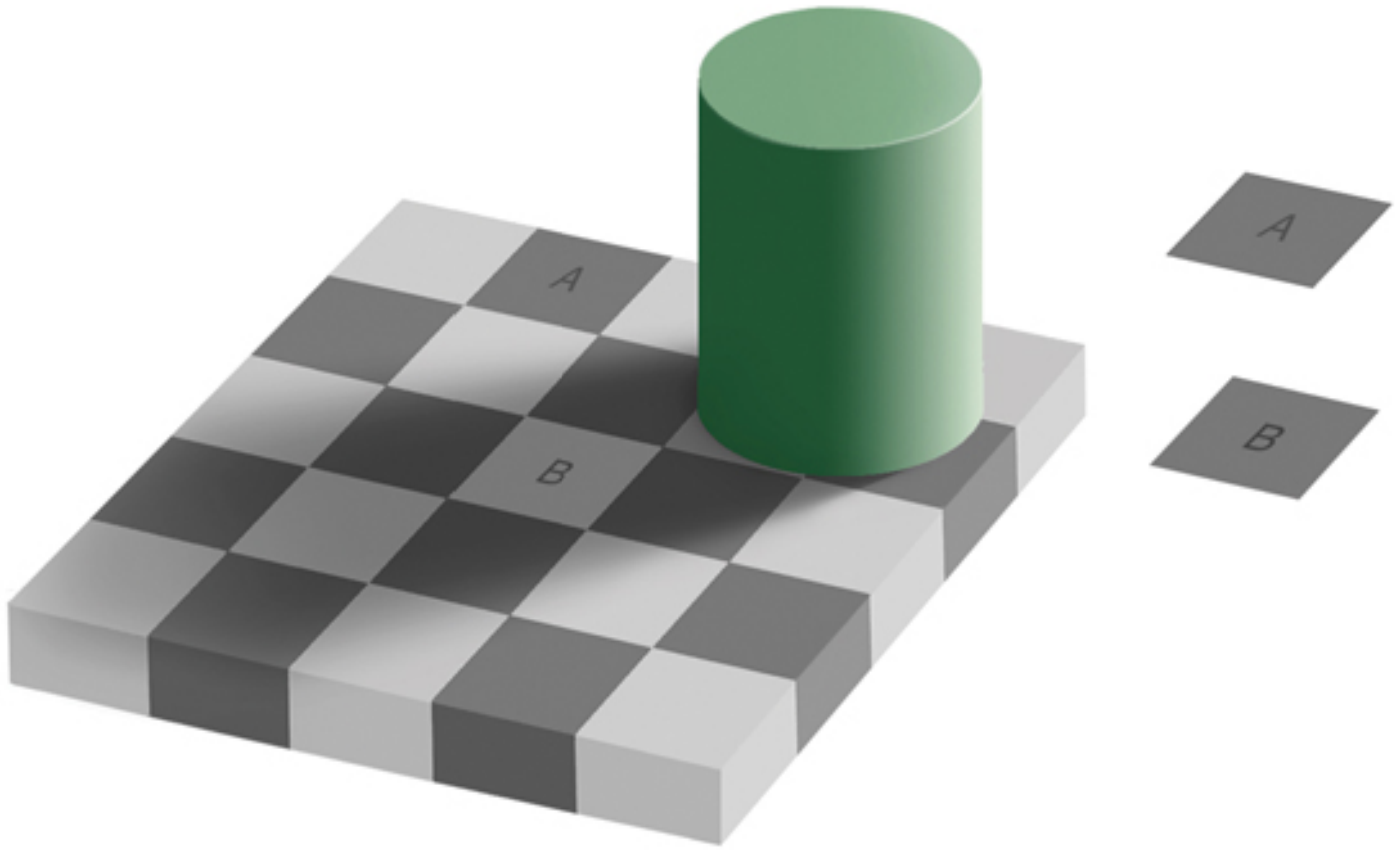
IVD - Institut für Visualisierung und Datenanalyse

Jun. Prof. Dr.-Ing. Boris Neubert
Karlsruhe Institut für Technologie

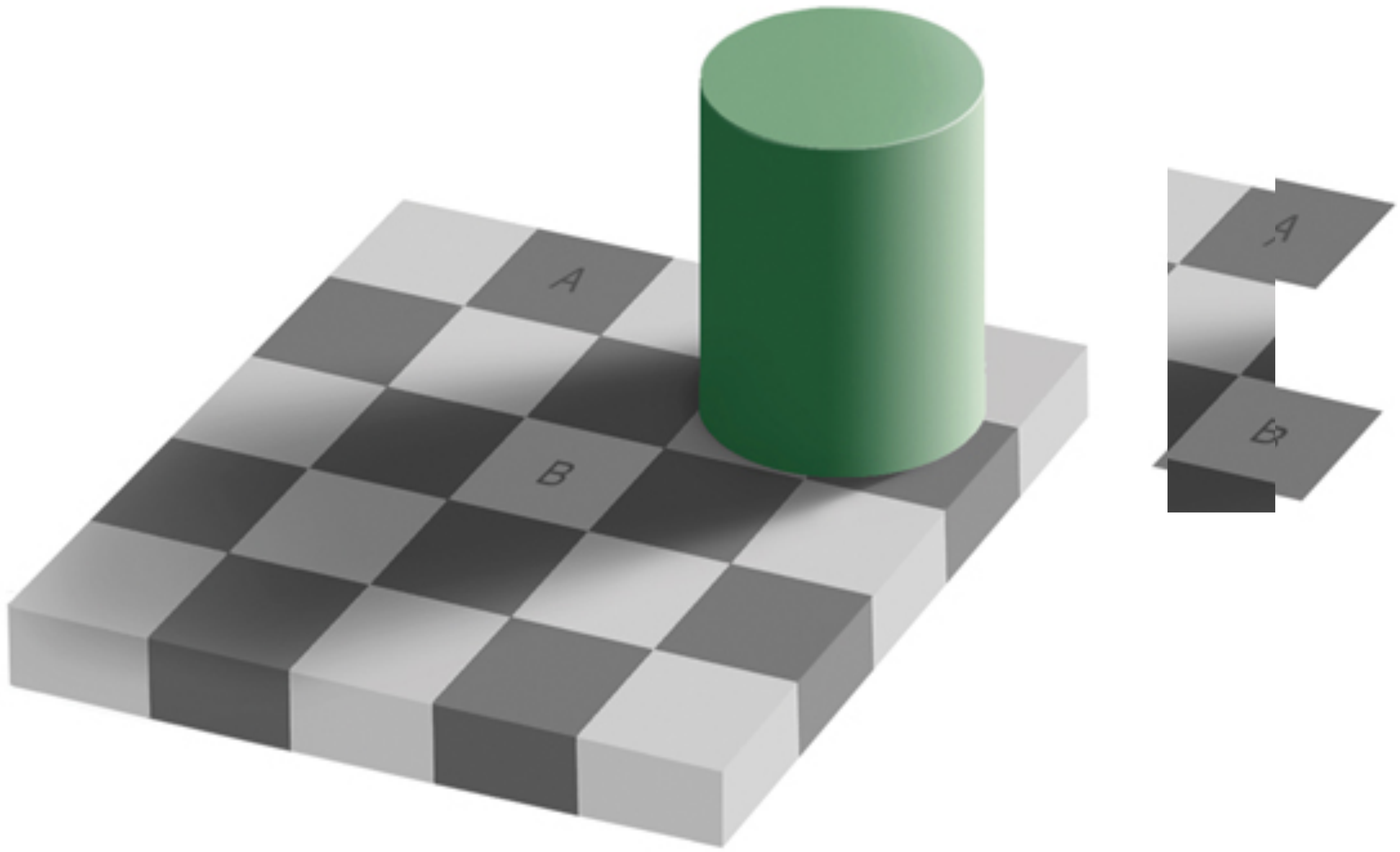
Perception



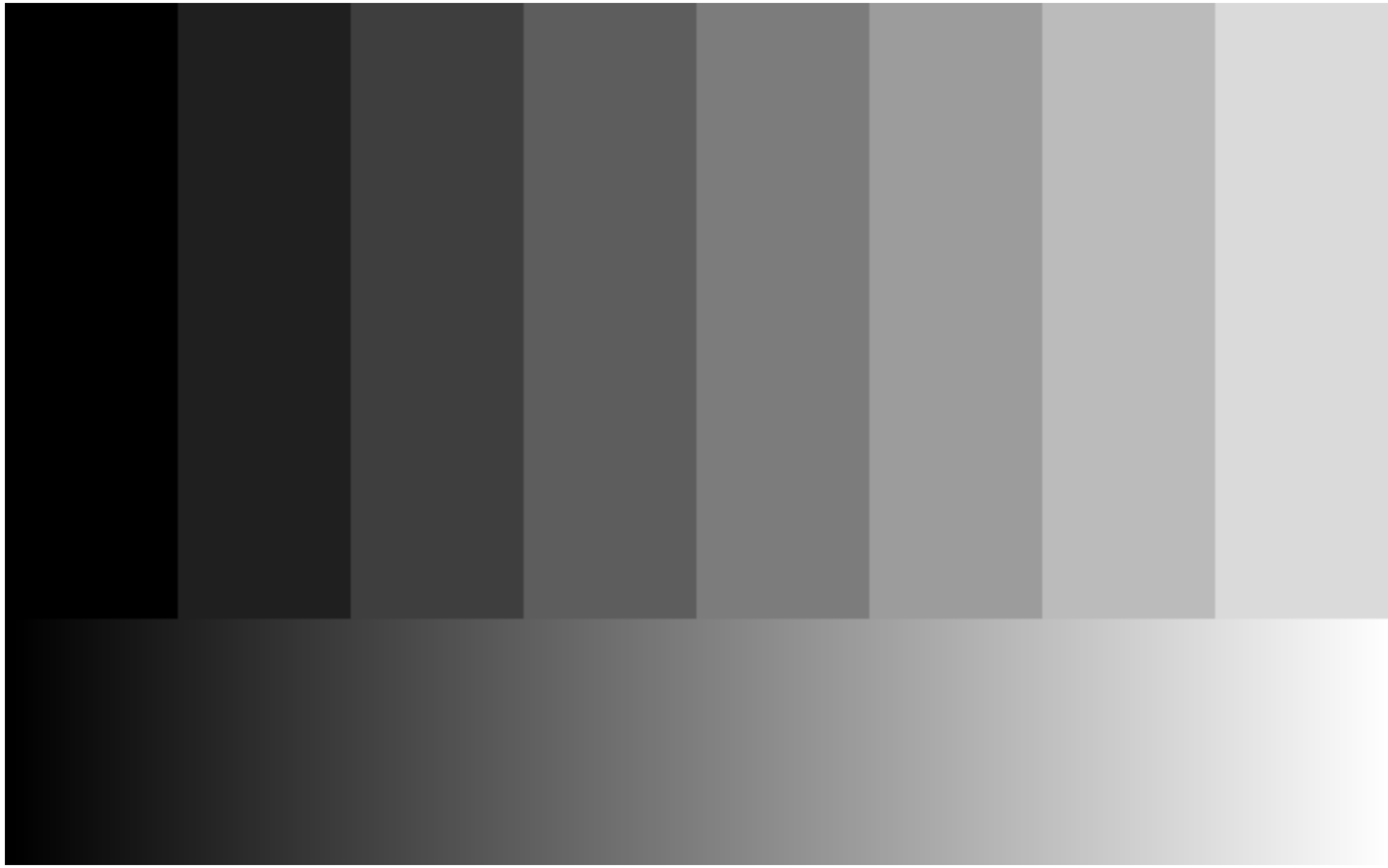
Perception



Perception

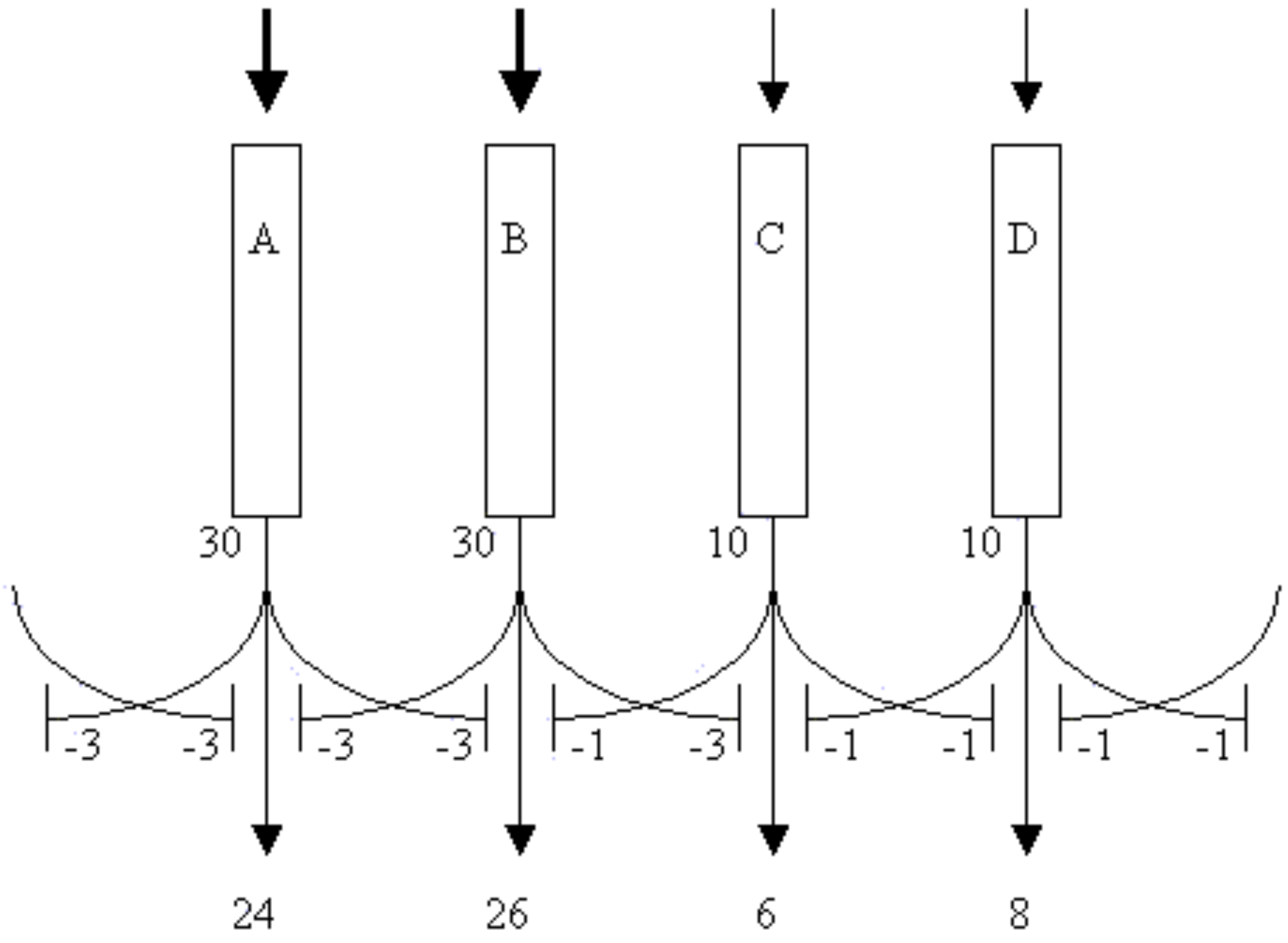


Mach Band



Von Polini 14:14, 30. Mär. 2008 (CEST) - selbst erstellt, CC BY-SA 3.0, https://de.wikipedia.org/w/index.php?curid=3444969

Receptive Field



Unisono01 - Bild selbst erstellt, Public Domain., PD-Schöpfungshöhe, https://de.wikipedia.org/w/index.php?curid=741732

Gaussian Pyramid

Gaussian Kernel (blurring kernel)

$$K = [-0.05,\ 0.25,\ 0.6,\ 0.25,\ -0.05]^\top\ [-0.05,\ 0.25,\ 0.6,\ 0.25,\ -0.05]$$

$$G_i = (K * G_{i-1})_{\downarrow 2}, \quad i = 1, \ldots, N$$

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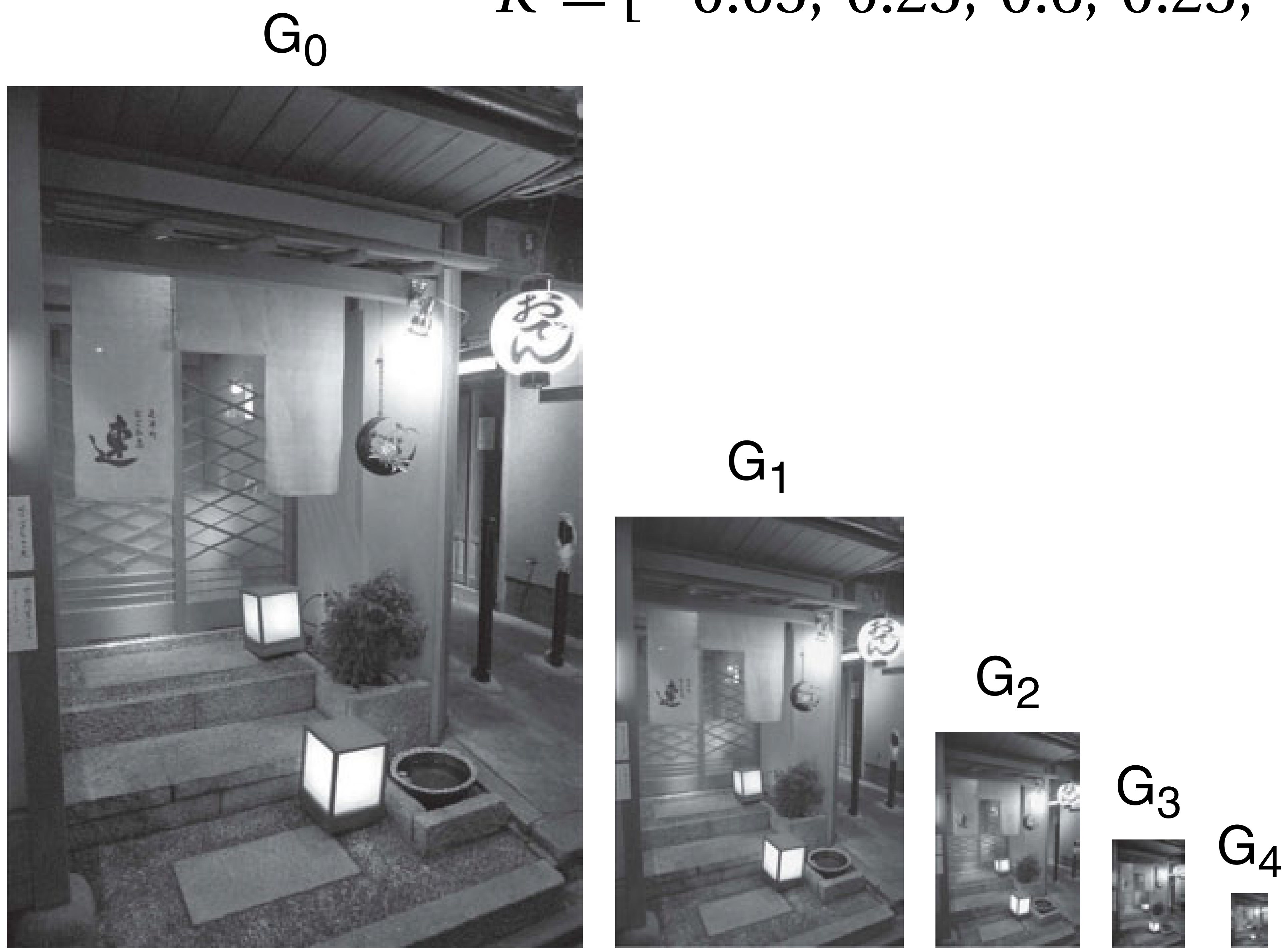

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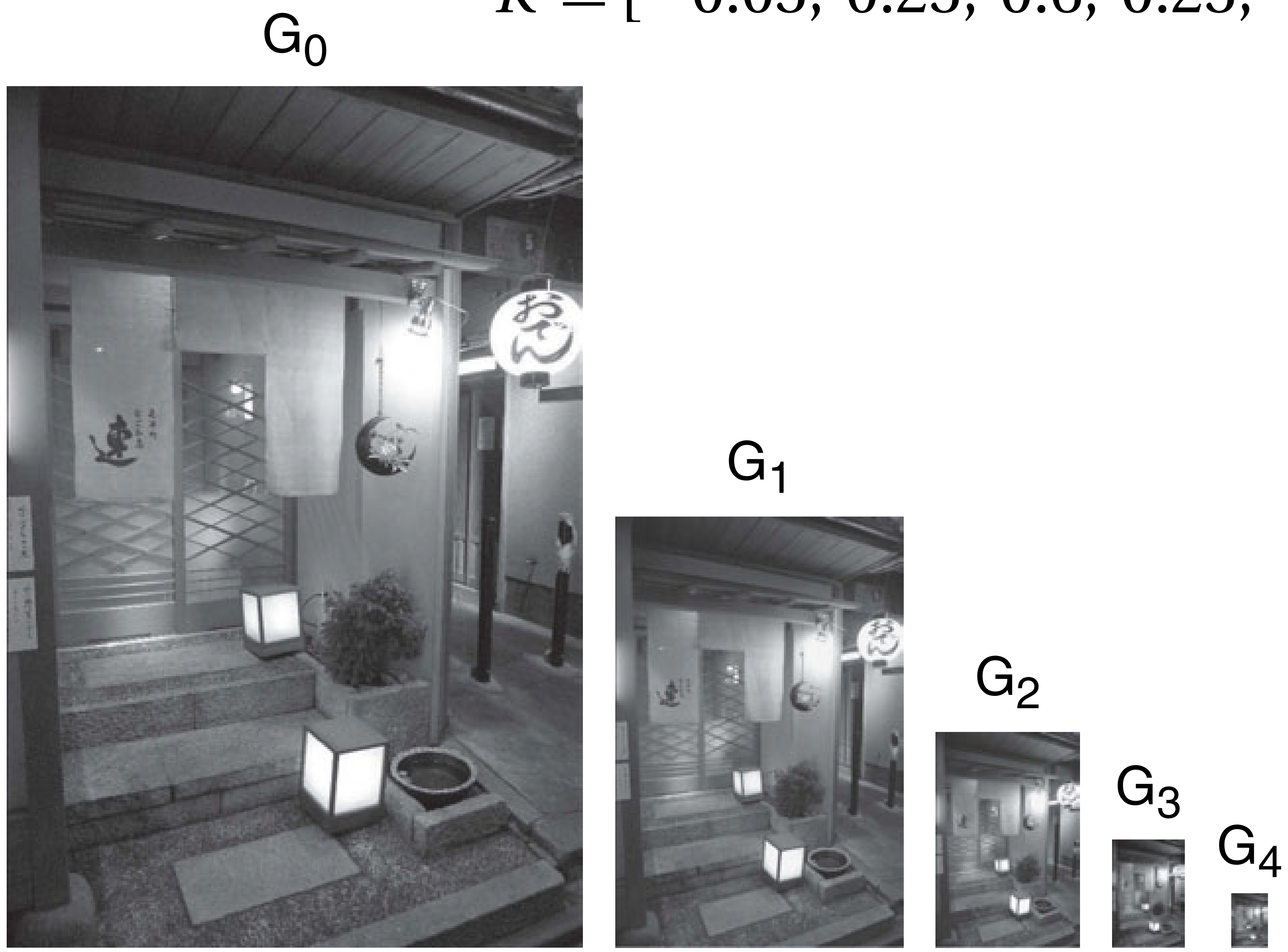

$$G_0 * K$$

$$G_i = (K * G_{i-1})_{\downarrow 2}, \quad i = 1, \ldots, N$$

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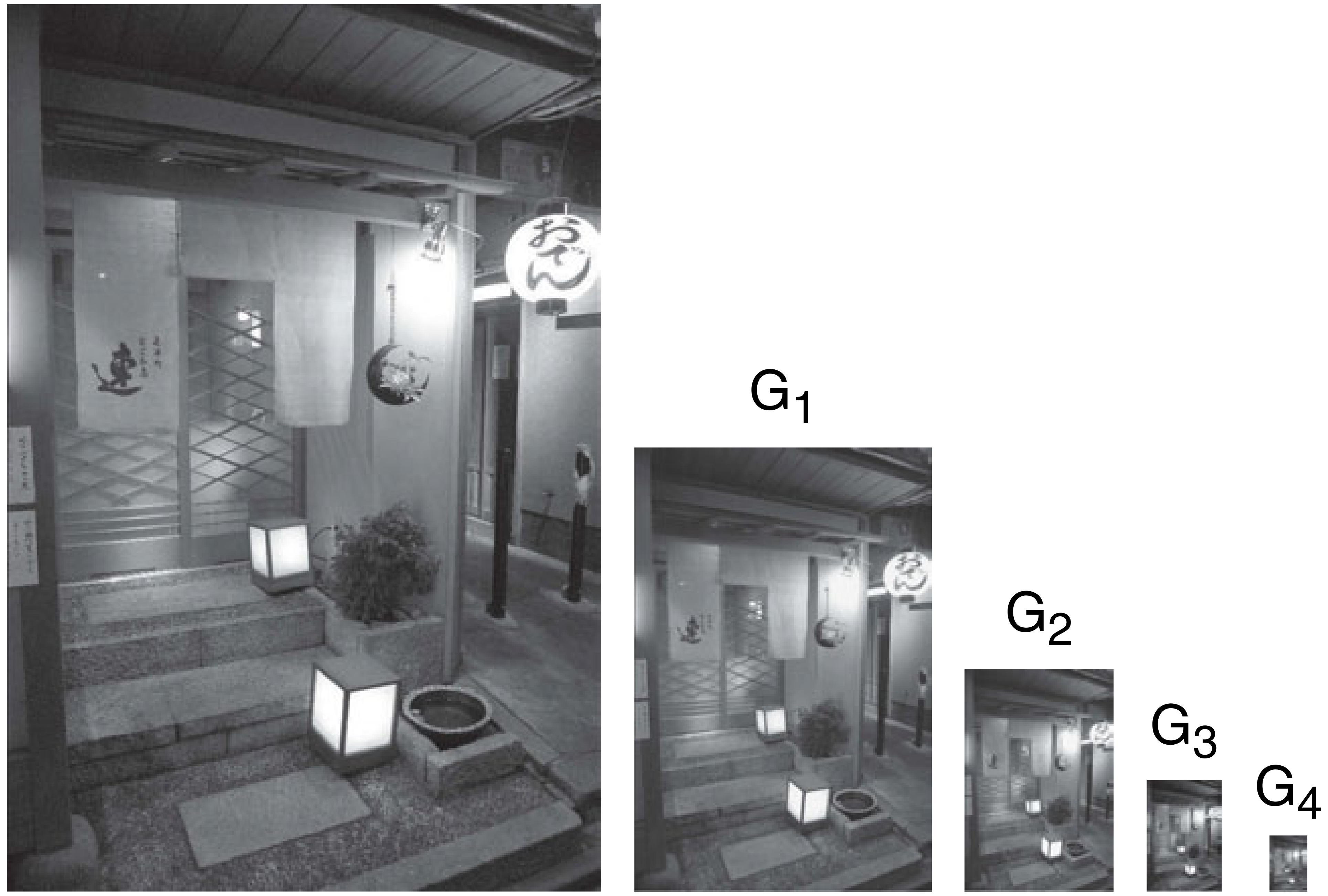
G0



$$G_0 * K$$

$$G_1 = (G_0 * K)_\downarrow$$

$$G_i = (K * G_{i-1})_{\downarrow 2}, \quad i = 1, \ldots, N$$

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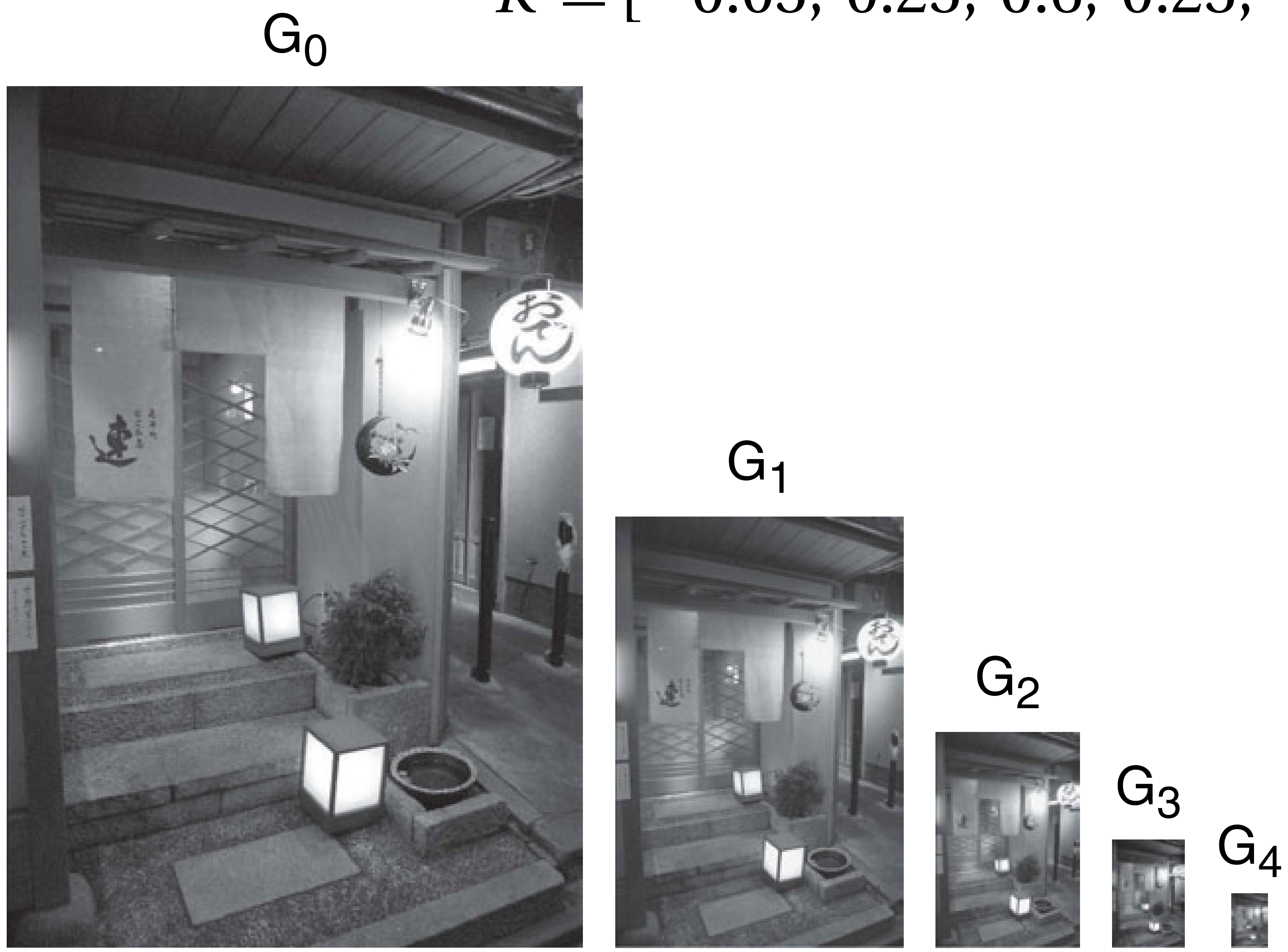


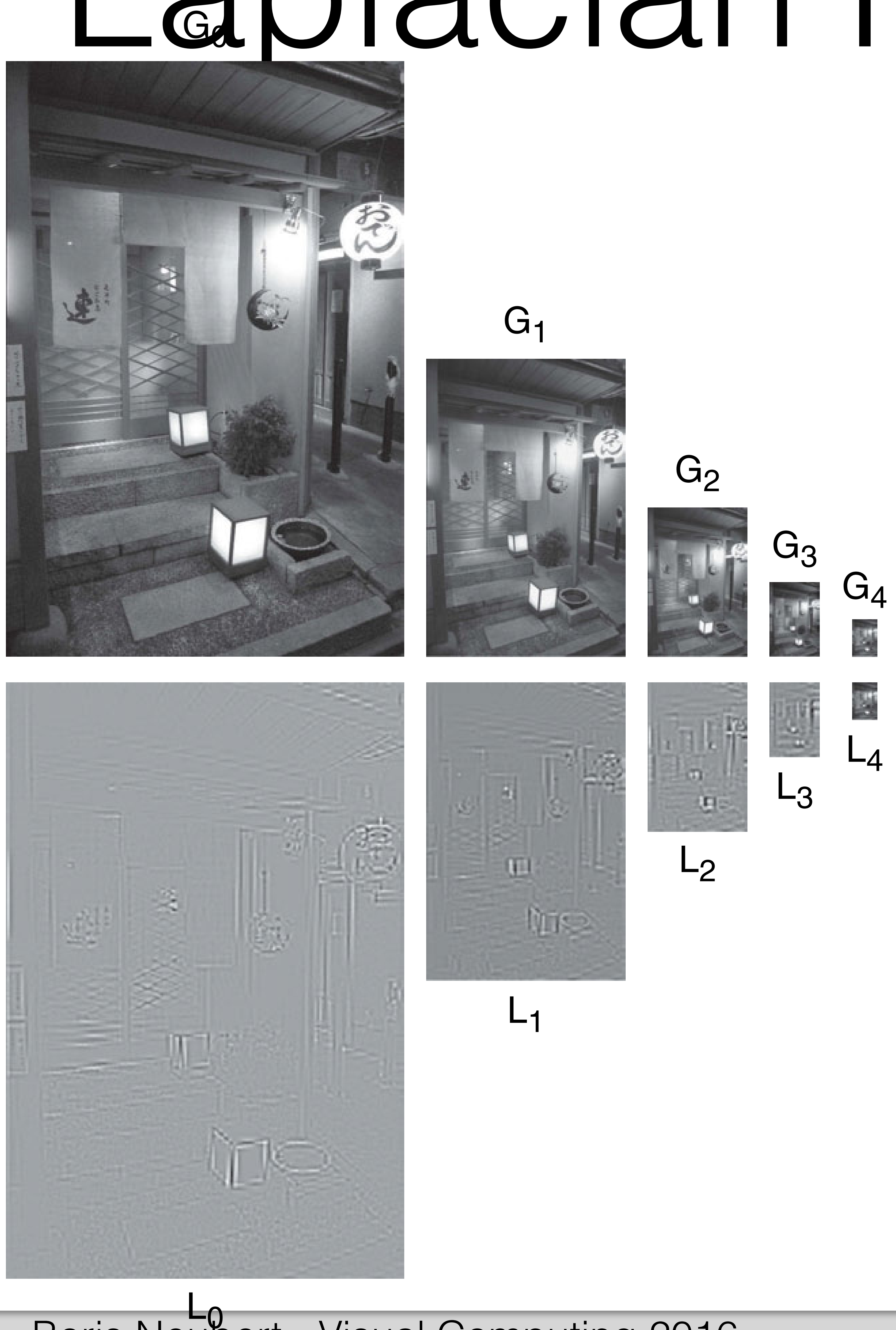
$$G_0 * K$$

$$G_1 = (G_0 * K)_\downarrow$$

$$G_i = (K * G_{i-1})_{\downarrow 2}, \quad i = 1, \ldots, N$$

$$L_i = G_i - (K * G_i), \quad i = 0, \ldots, N-1$$

Laplacian Pyramid



$$I = \sum_{i=0}^{N} L_{i\uparrow}$$

Multiresolution Blending

build Laplacian pyramid for composite image
with Gaussian G of map M and Laplacians L of source S and target T:

$$L_0^C = G_0^M L_0^S + (1 - G_0^M) L_0^T$$

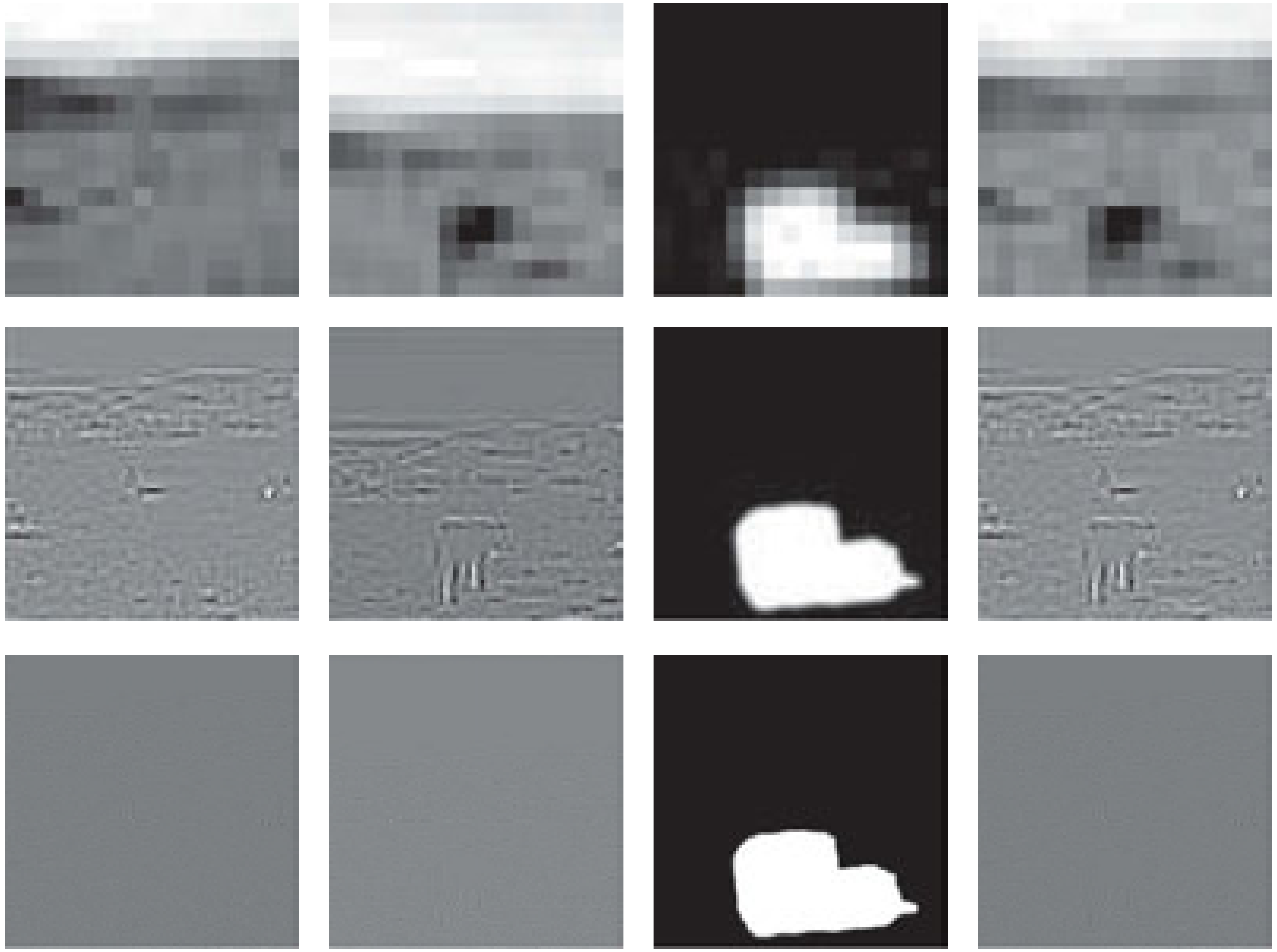
$$\vdots$$

$$L_N^C = G_N^M L_N^S + (1 - G_N^M) L_N^T$$

combine upsampled Laplacians to final composite image:

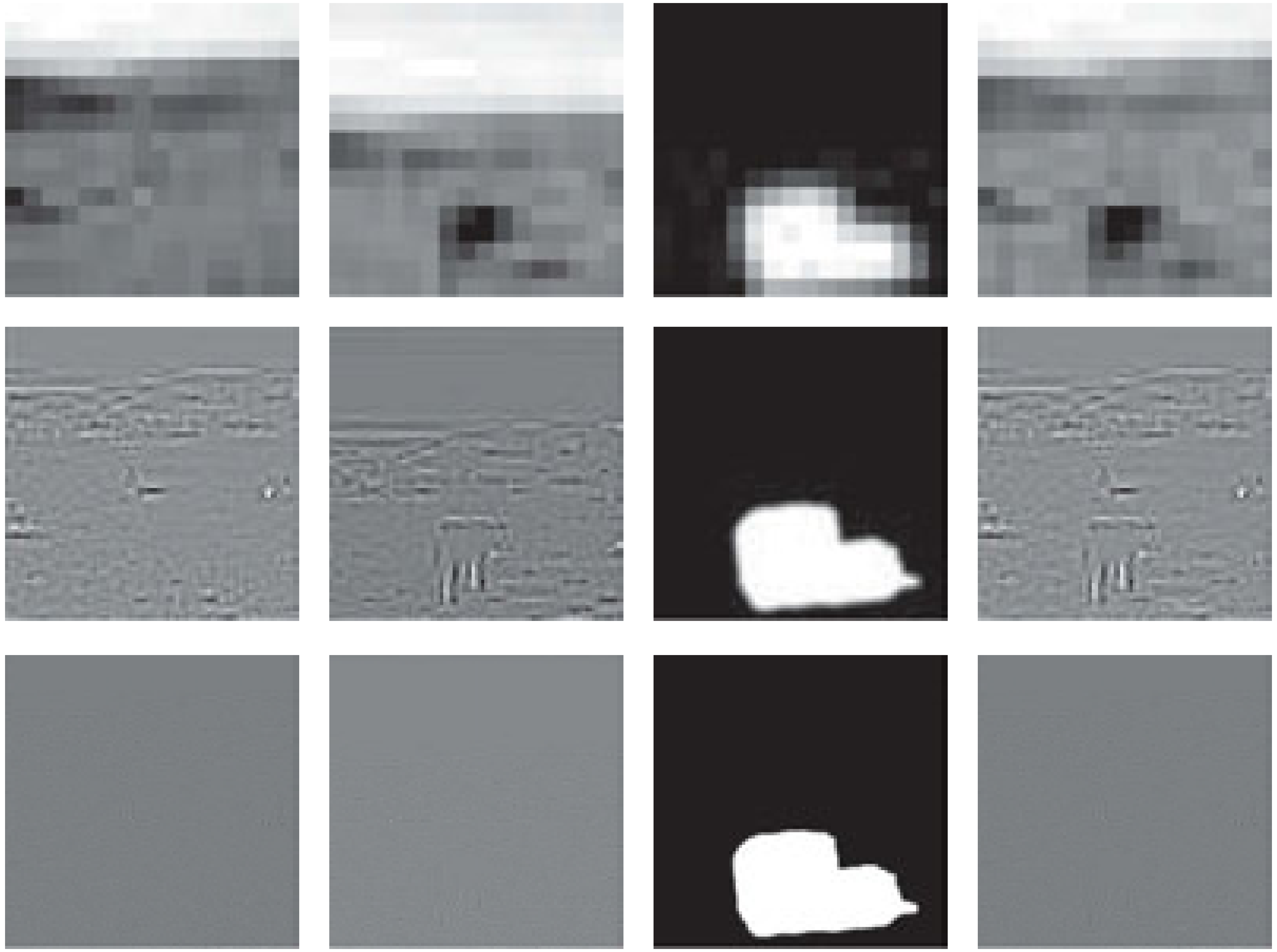
$$I^C = \sum_{i=0}^{N} (L_i^C)_{\uparrow}$$

Multiresolution Blending



(c) (d) (e) (f)

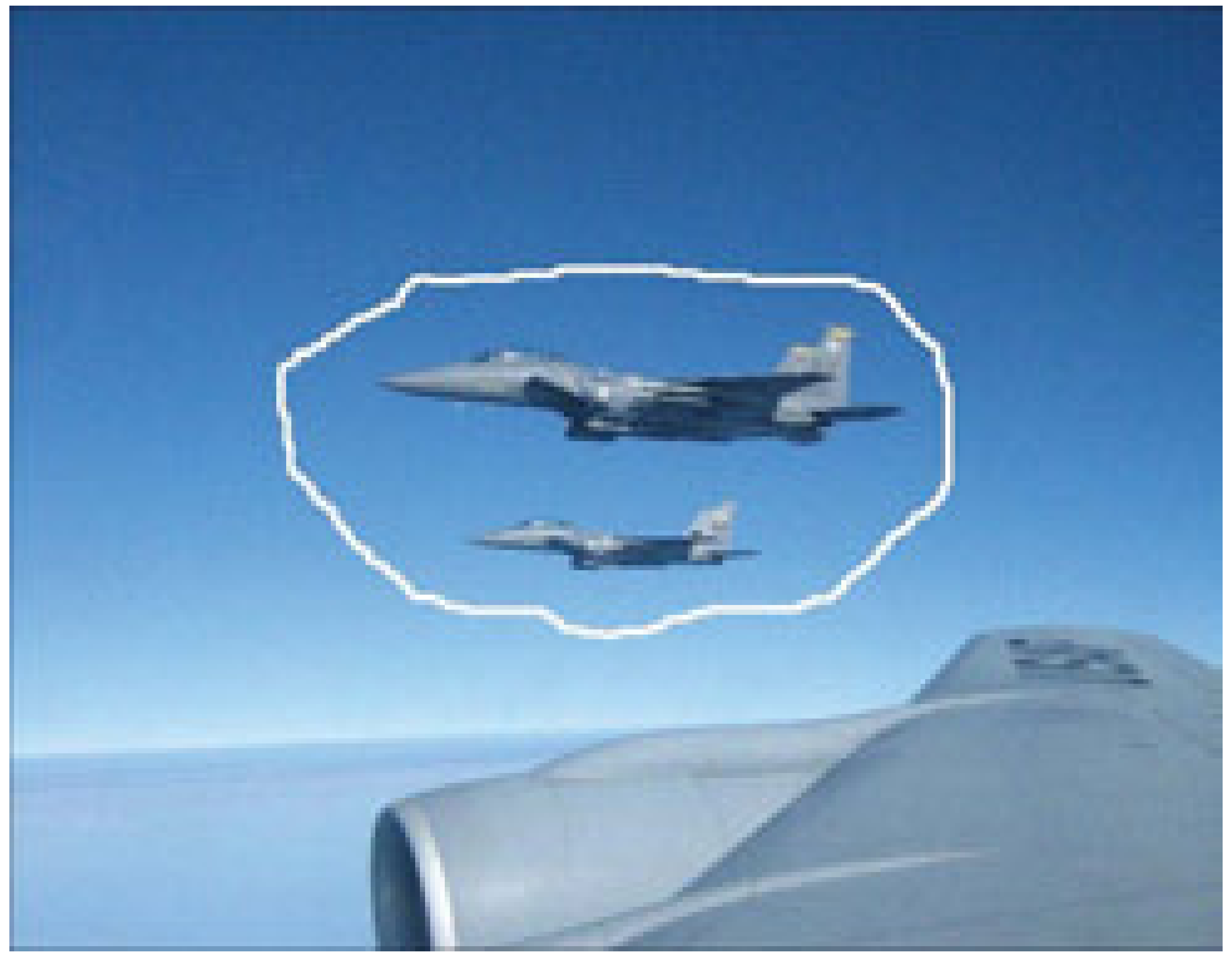
Multiresolution Blending



(c) (d) (e) (f)

Difficult Example

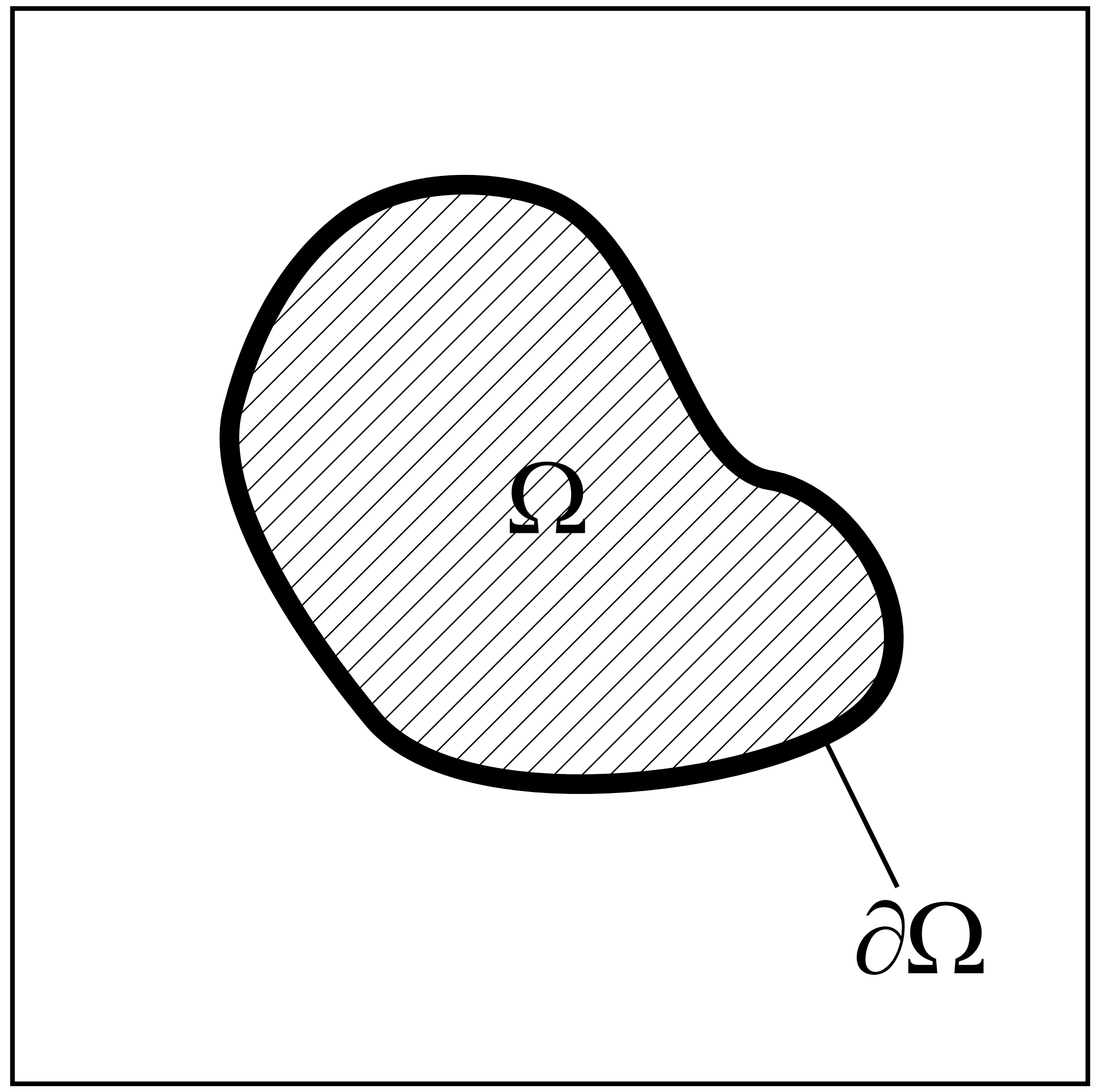
(a)



(b)

(c)

Poisson/Gradient domain



Problem Formulation

$$\min_{I(x,y)\in\Omega} \iint_{\Omega} \|\nabla I(x,y) - \nabla S(x,y)\|^2 \, dx\, dy$$

$$s.t.\ \ I(x,y) = T(x,y) \ \text{ on } \partial\Omega$$

Problem Formulation

$$\min_{I(x,y)\in\Omega} \iint_{\Omega} \|\nabla I(x,y) - \nabla S(x,y)\|^2 \, dx\, dy$$

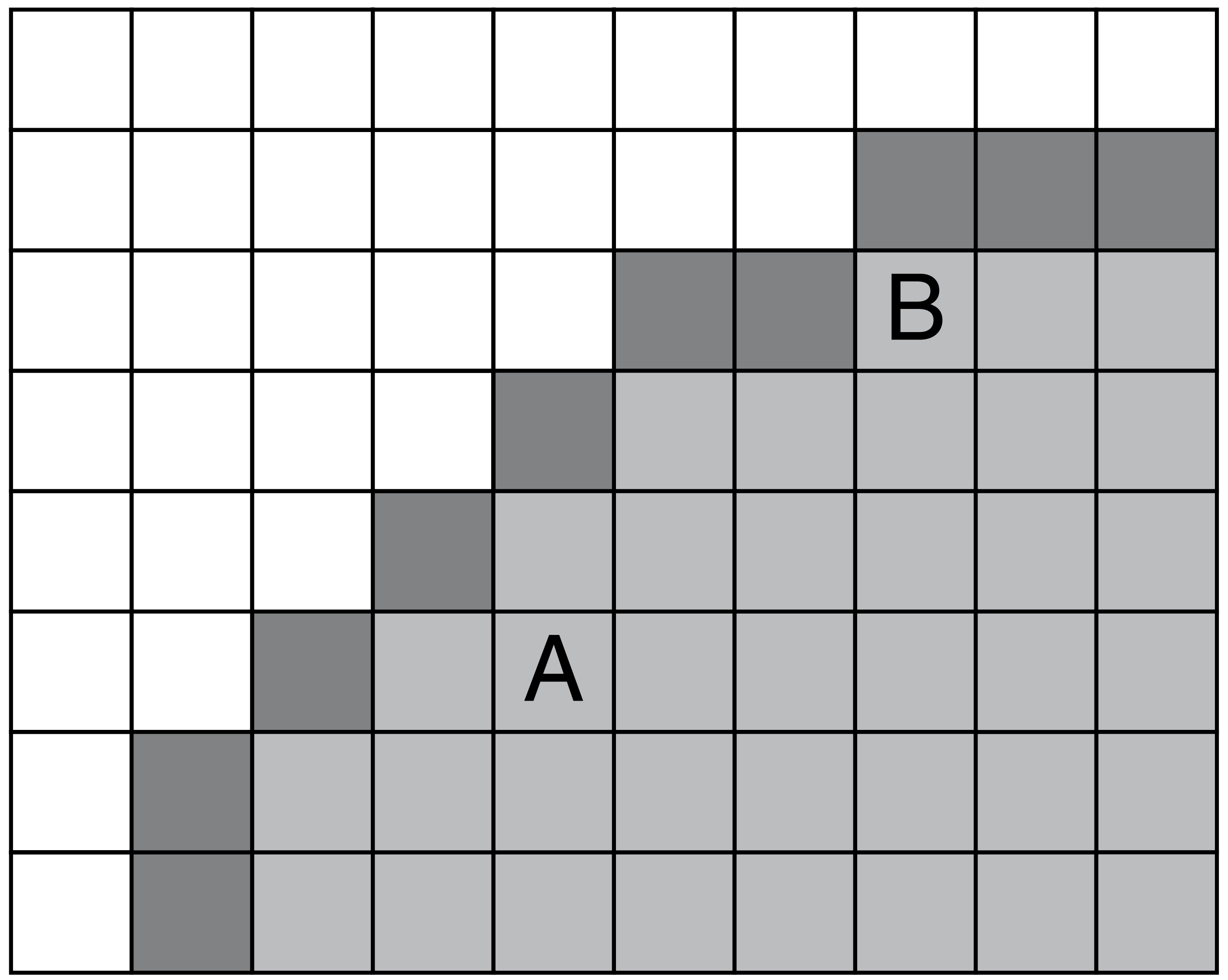
$$s.t.\ \ I(x,y) = T(x,y) \ \text{ on } \partial\Omega$$

$$\nabla^2 I(x,y) = \nabla^2 S(x,y) \ \text{ in } \Omega$$

$$s.t.\ \ I(x,y) = T(x,y) \ \text{ on } \partial\Omega$$

Problem Formulation

$$I(x+1,y)+I(x-1,y)+I(x,y+1)+I(x,y-1)-4I(x,y)$$
$$= S(x+1,y)+S(x-1,y)+S(x,y+1)+S(x,y-1)-4S(x,y) \quad (3.14)$$

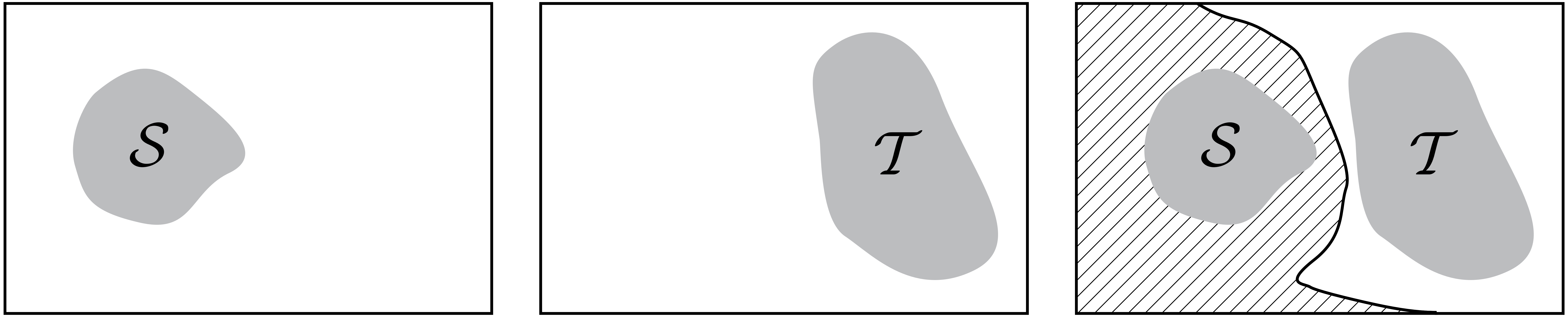


$$\left(\sum_{q\in\mathcal{N}(p)\cap\Omega} I(q)\right)+\left(\sum_{q\in\mathcal{N}(p)\cap\partial\Omega} T(q)\right)-4I(x,y)$$
$$= S(x+1,y)+S(x-1,y)+S(x,y+1)+S(x,y-1)-4S(x,y)$$

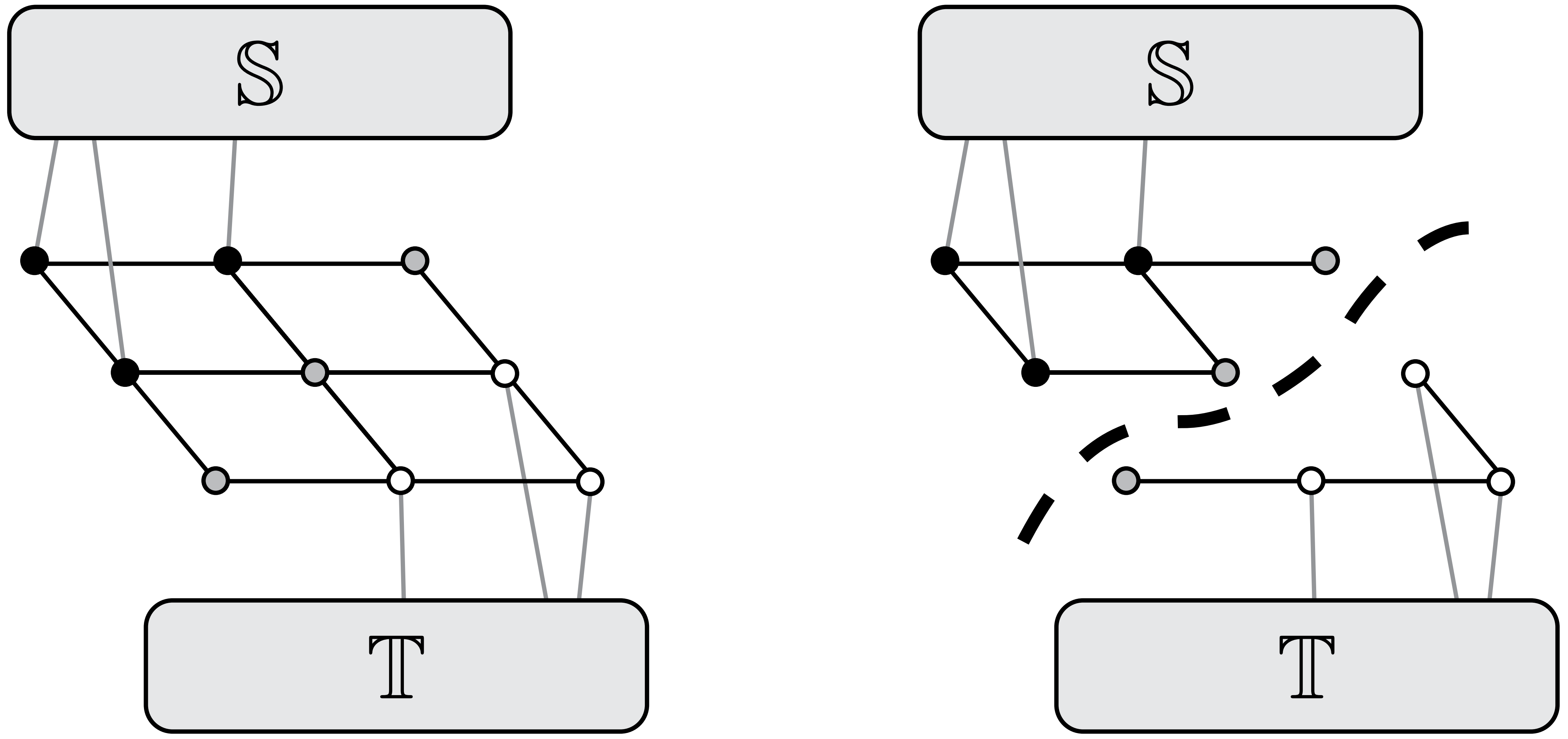
Results

Difficult Example (Failure Case)

Graph Cut



Solution to a Graph Cut Problem



(a) (b)

Min-Cut

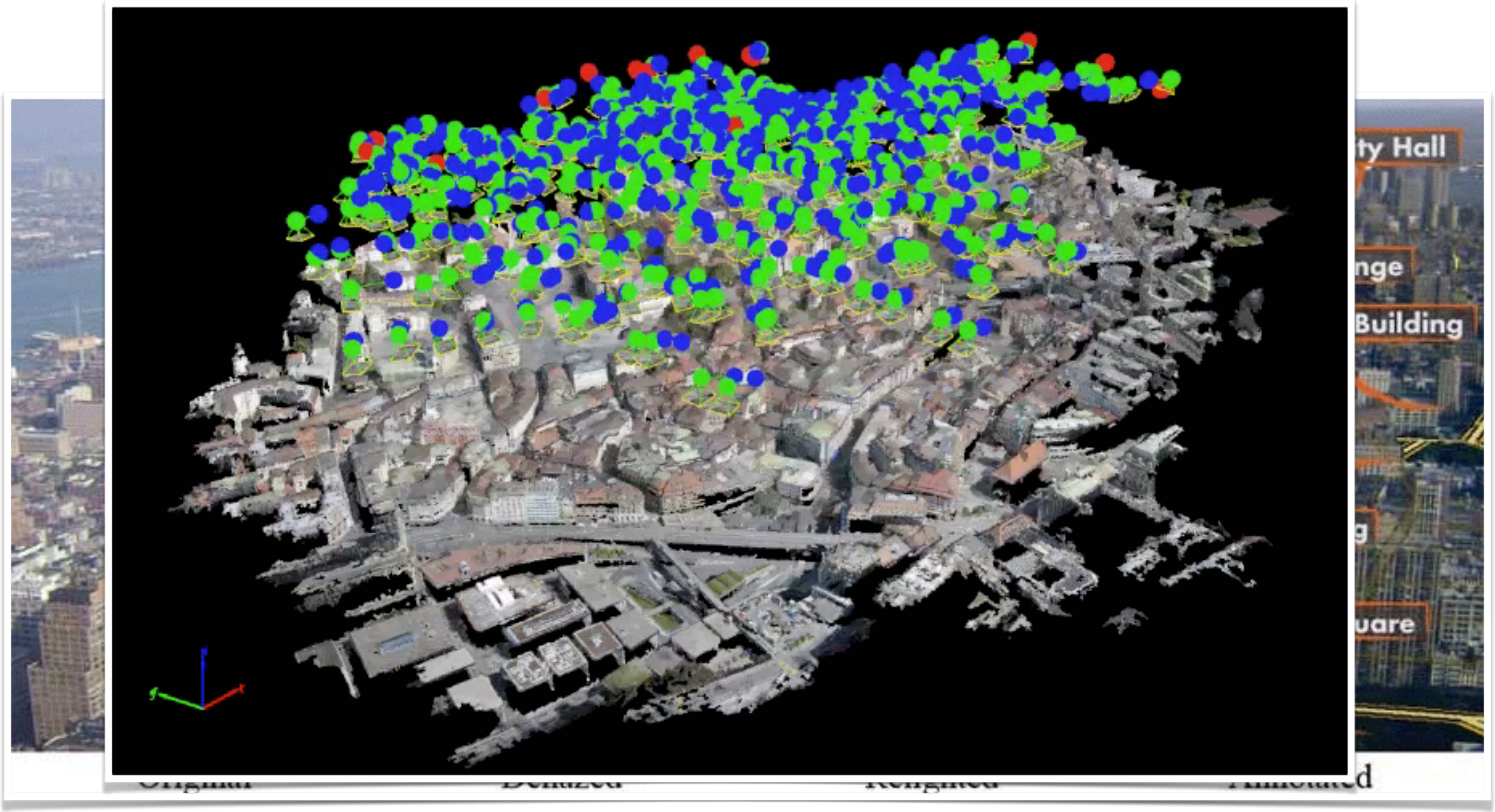
$$|\mathcal{C}| = \sum_{(i,j)\in\mathcal{C}} w_{ij}$$

Images + Geometry

Images + Geometry

Original Dehazed Relighted Annotated

Images + Geometry



Related Projects @ Microsoft Research

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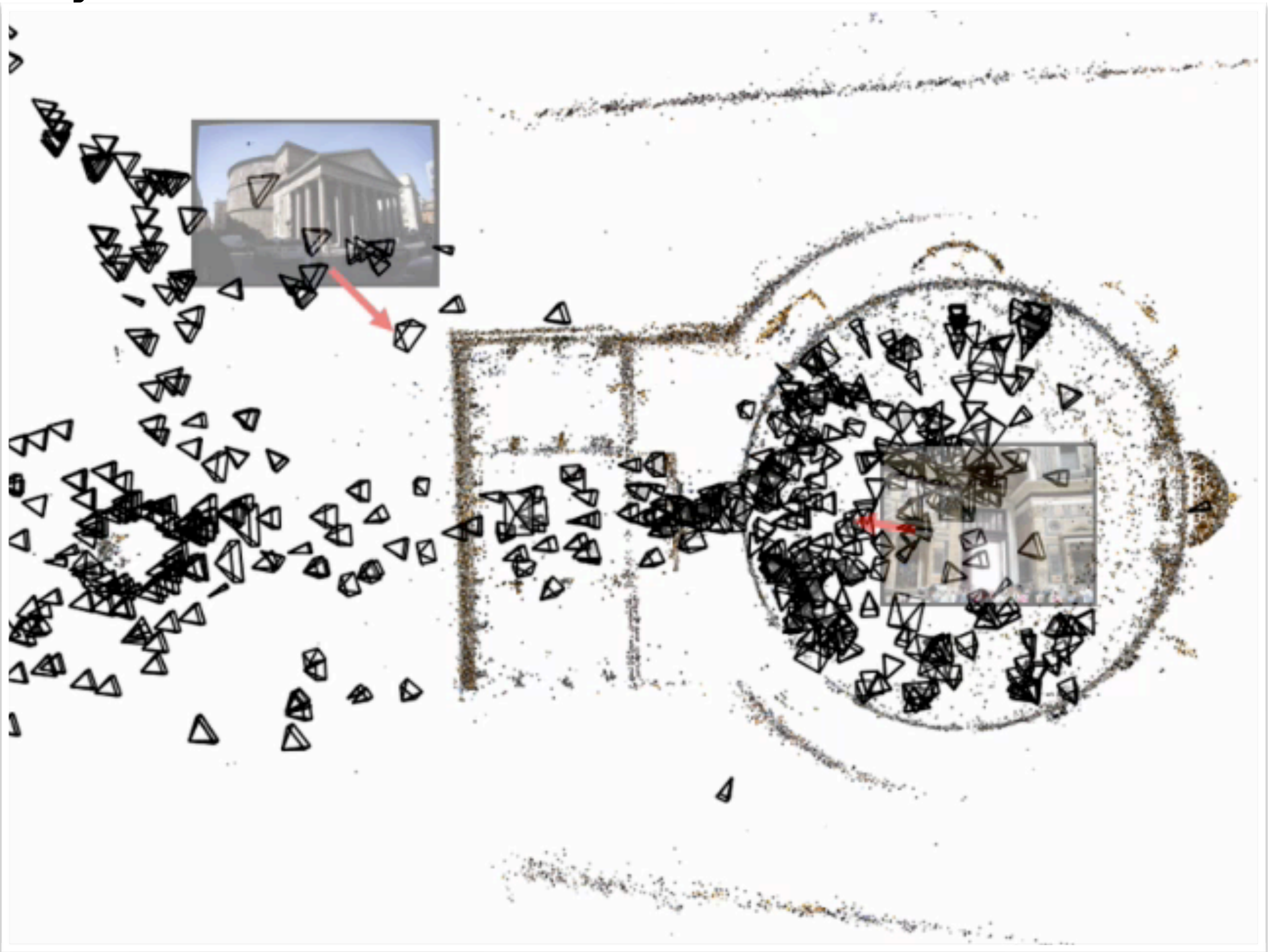
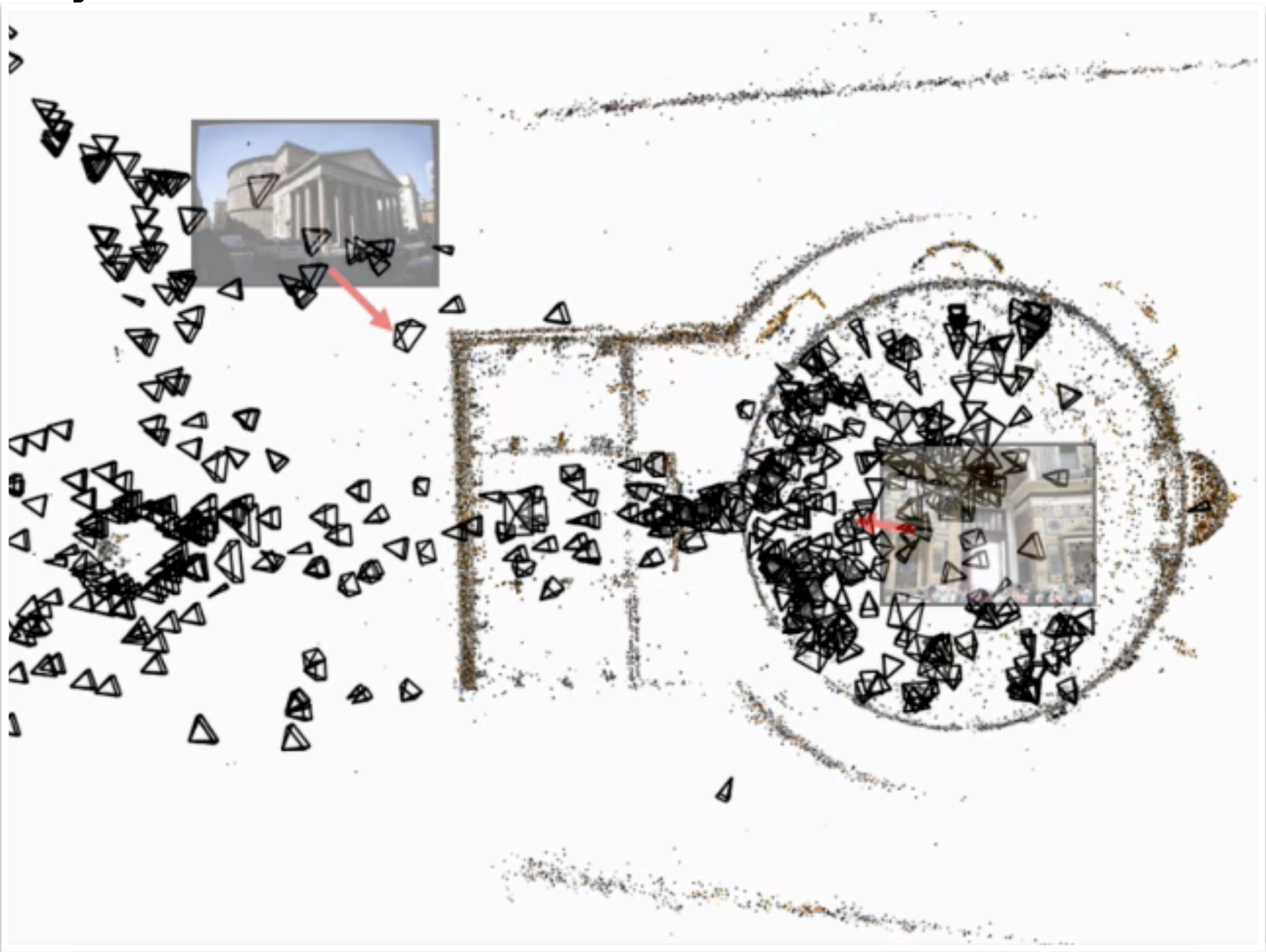
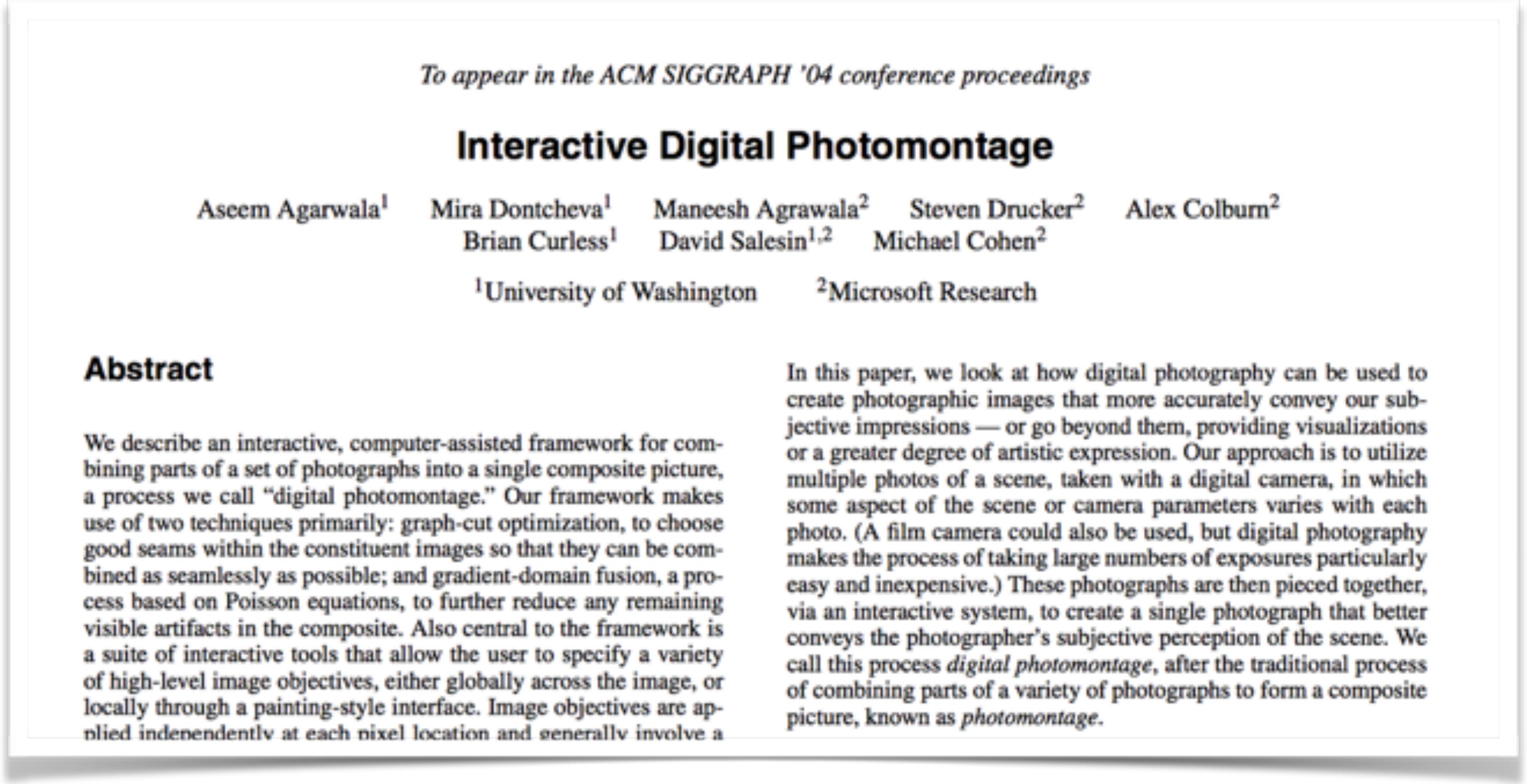


Related Projects @ Microsoft Research



References

- [CVFX] Computer Vision for Visual Effects, R.Radke,
  Poisson Image Editing Sec. 3.2.
  Graph-Cut Compositing Sec. 3.3.



To appear in the ACM SIGGRAPH '04 conference proceedings

Interactive Digital Photomontage

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Brian Curless[1] David Salesin[1,2] Michael Cohen[2]

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Abstract

We describe an interactive, computer-assisted framework for combining parts of a set of photographs into a single composite picture, a process we call "digital photomontage." Our framework makes use of two techniques primarily: graph-cut optimization, to choose good seams within the constituent images so that they can be combined as seamlessly as possible; and gradient-domain fusion, a process based on Poisson equations, to further reduce any remaining visible artifacts in the composite. Also central to the framework is a suite of interactive tools that allow the user to specify a variety of high-level image objectives, either globally across the image, or locally through a painting-style interface. Image objectives are applied independently at each pixel location and generally involve a

In this paper, we look at how digital photography can be used to create photographic images that more accurately convey our subjective impressions — or go beyond them, providing visualizations or a greater degree of artistic expression. Our approach is to utilize multiple photos of a scene, taken with a digital camera, in which some aspect of the scene or camera parameters varies with each photo. (A film camera could also be used, but digital photography makes the process of taking large numbers of exposures particularly easy and inexpensive.) These photographs are then pieced together, via an interactive system, to create a single photograph that better conveys the photographer's subjective perception of the scene. We call this process *digital photomontage*, after the traditional process of combining parts of a variety of photographs to form a composite picture, known as *photomontage*.

- Photomontage:
  http://grail.cs.washington.edu/projects/photomontage/

Exercise

- Poisson Image Blending (Additional: How to solve the problematic case -)
- Visualize Probability Distributions of BM and influence of sigma: potential libraries bokeh and seaborn.

Project

- Leap Motion / Intel Real Sense
- Oculus Rendering (GUI in VR)
- Photoscan Reconstruction