

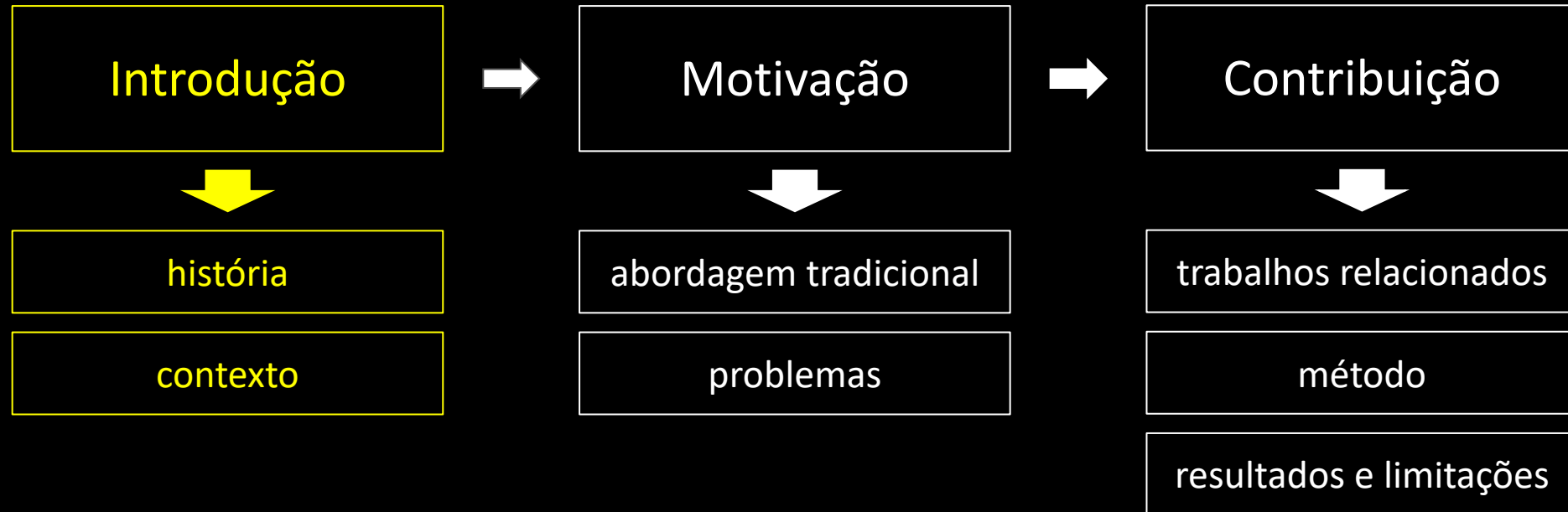


Harmonizando sombras para editar imagens com fotorrealismo

Lucas Valença

PhD Student
McGill University

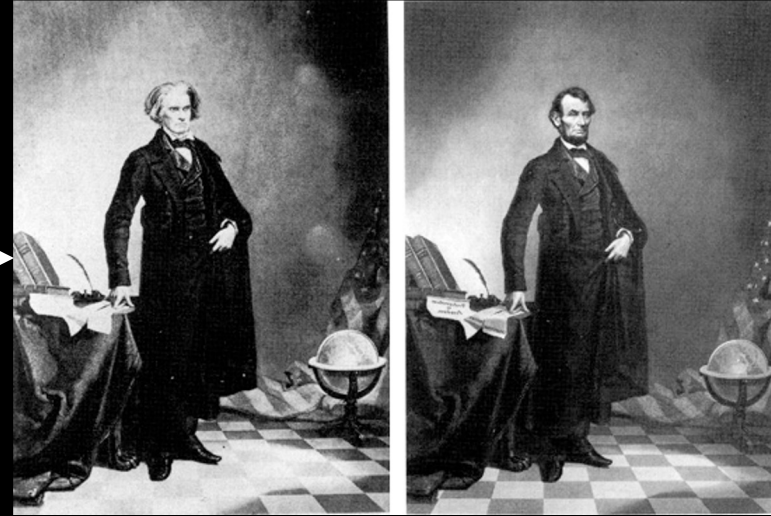
Estrutura



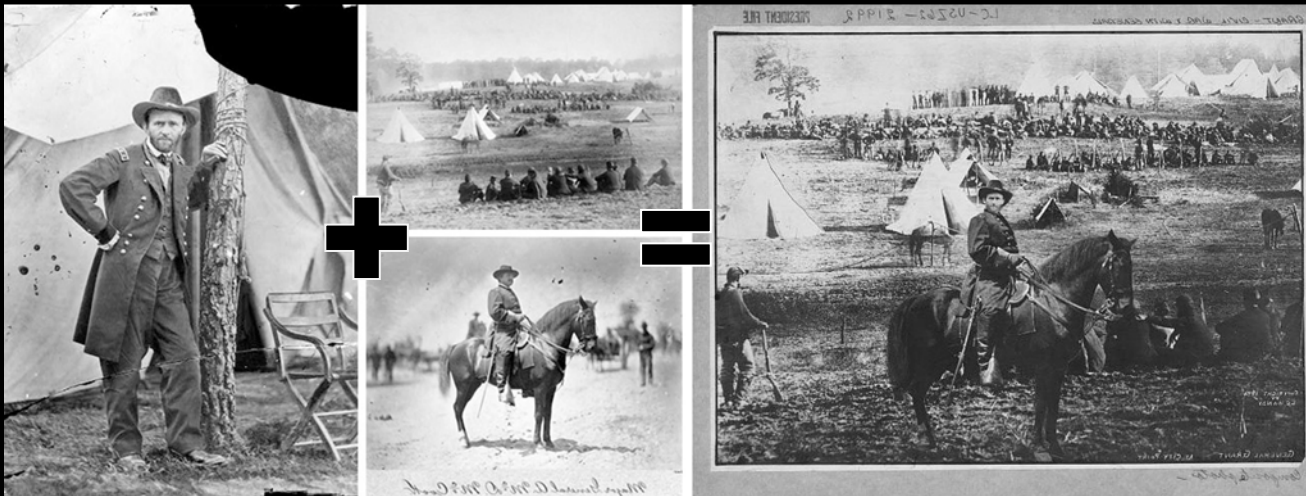
História: as primeiras fotografias editadas



primeira foto capturada por uma câmera
cerca de 1826



montagem com Abraham Lincoln
cerca de 1860



montagem do general
Ulysses. S. Grant na
guerra civil americana
cerca de 1864

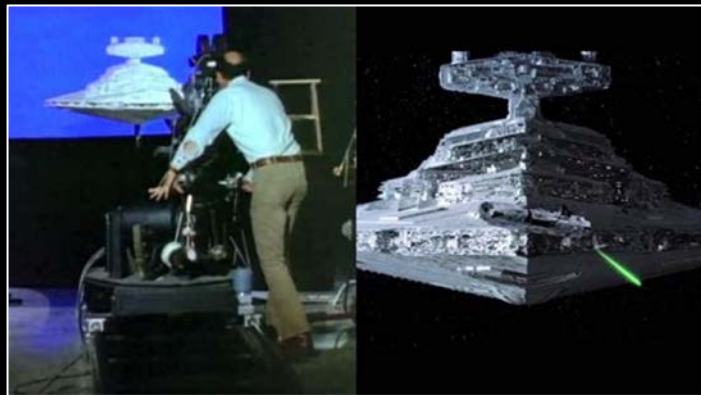
História: popularização da manipulação fotográfica



remoção de pessoas indesejadas por Stalin
cerca de 1930



The Invisible Man:
um dos primeiros exemplos de
optical compositing
1933

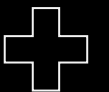


remoção de fundo azul em Star Wars
1977

cena completa (sem o ator)



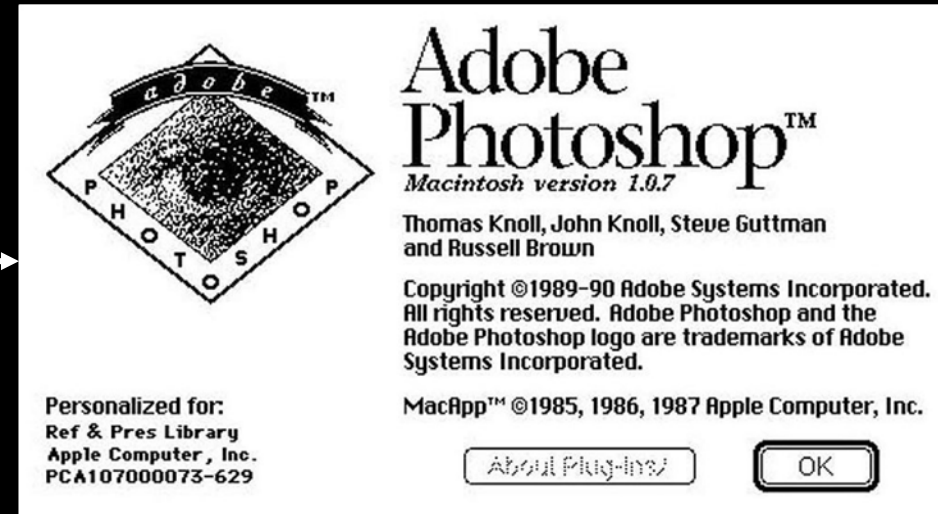
cena escura (com o ator)



História: edição de imagens na mídia



montagem artística de Oprah
1989 (esquerda), 1979 (direita)



Photoshop
1990



Deepfakes
cerca de 2016

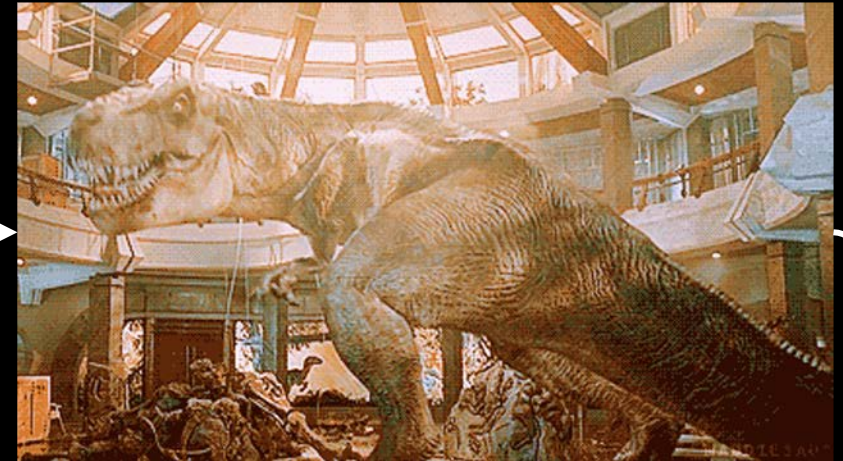
montagem seminua
(sem permissão)
de Britney Spears
2008



História: edição de imagens via elementos 3D



Young Sherlock Holmes:
primeira montagem com personagem 3D
1985



Jurassic Park
1992



The Da Vinci Code
2006

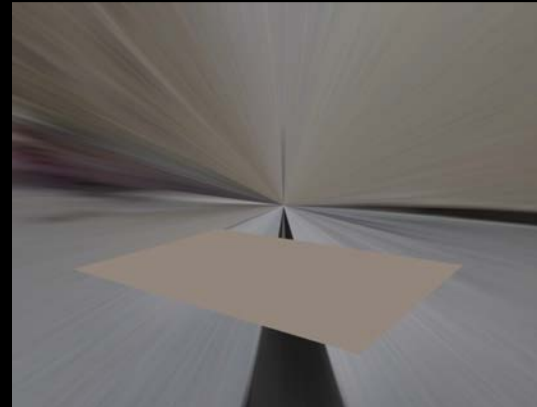


Avengers: Endgame
2019

Contexto: montagens fotorrealistas



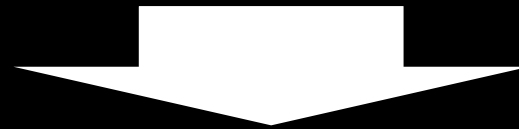
objetos virtuais



cena virtual



cena real

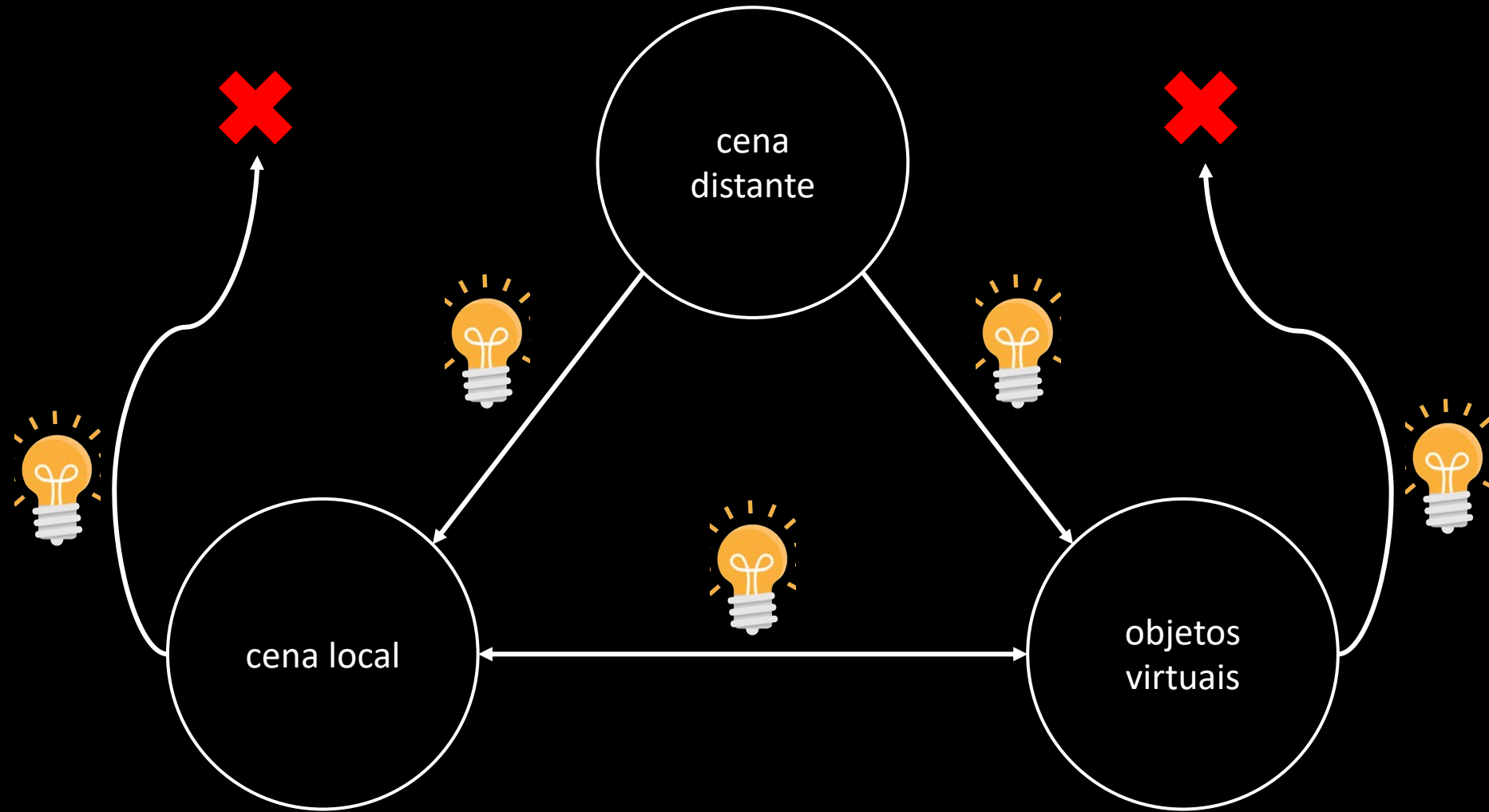


renderização

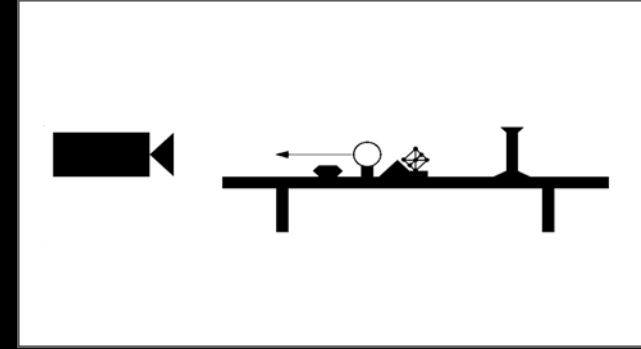
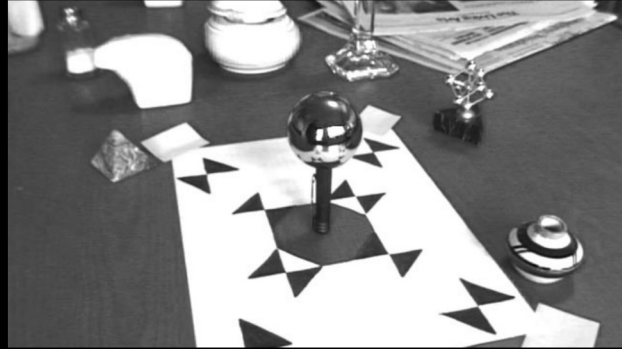


resultado

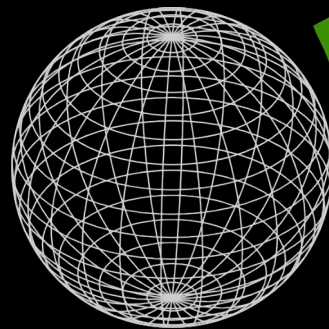
Contexto: iluminação baseada em imagens (IBL)



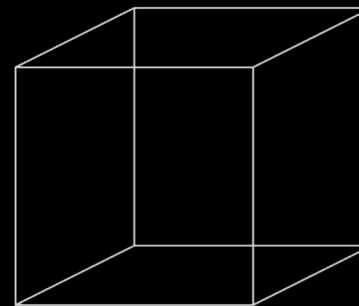
Contexto: cena distante (IBL)



calibração de câmera e captura de iluminação (*environment map*)



aproximação
simples

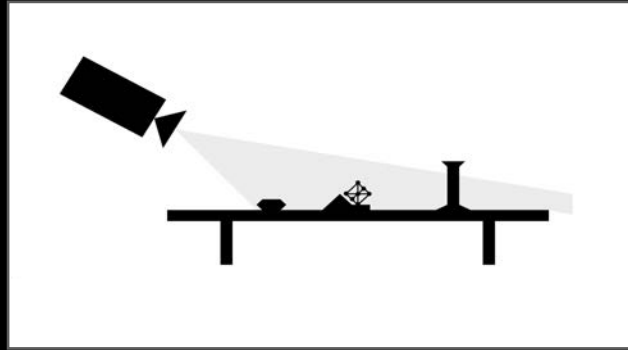
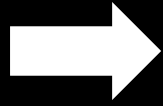


aproximação por
medições

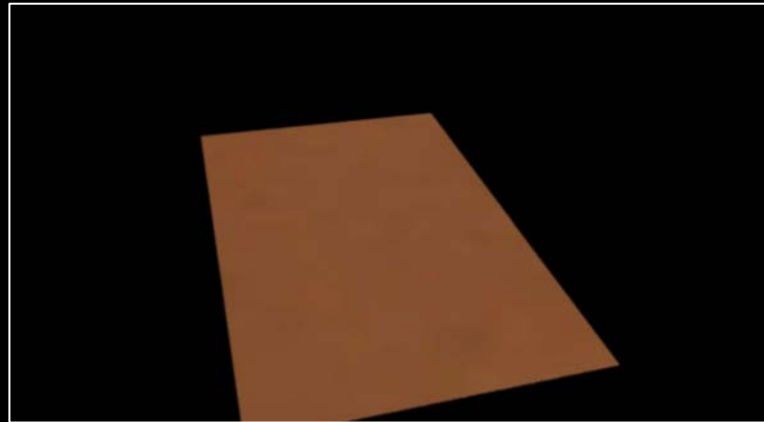


reconstrução 3D
completa

Contexto: cena local (IBL)



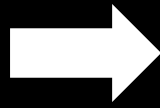
posicionamento e captura de cena "real"



estimativa de superfície (geometria, albedo e coeficiente de difusão)

Contexto: objetos virtuais (IBL)

objetos virtuais



cena real



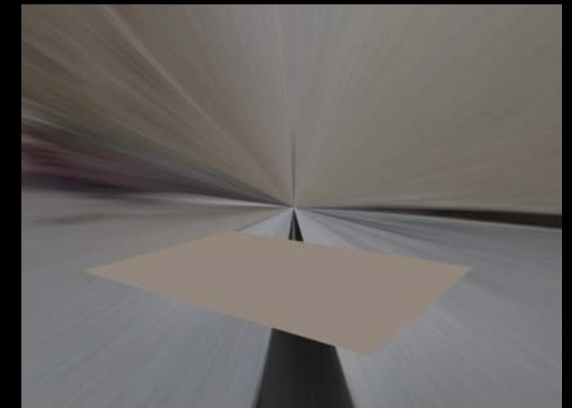
estimativa de iluminação



cena local + objetos virtuais



objetos virtuais



cena local

Contexto



ilumi



objetos +
na local

Contexto: resultados (IBL)



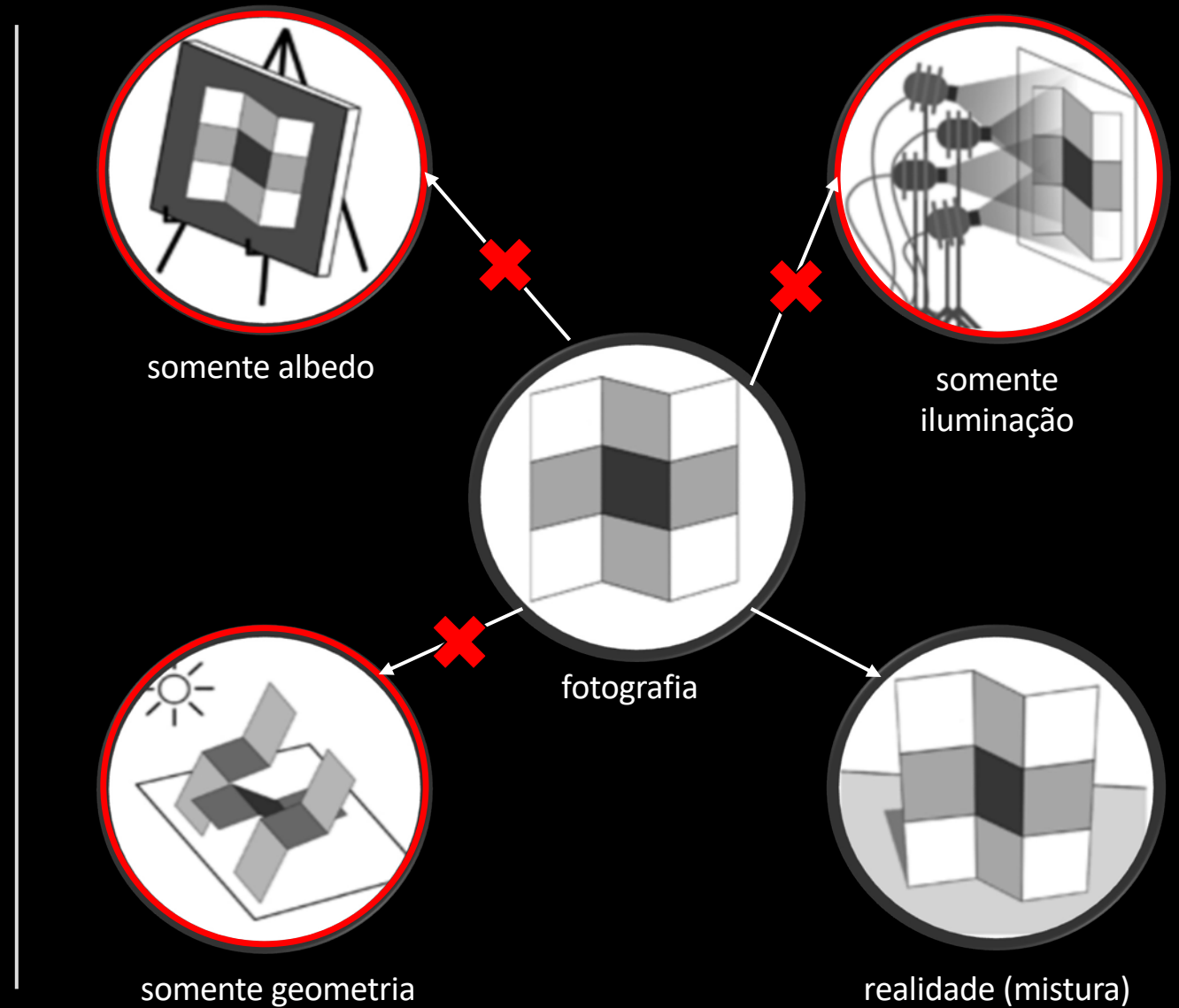
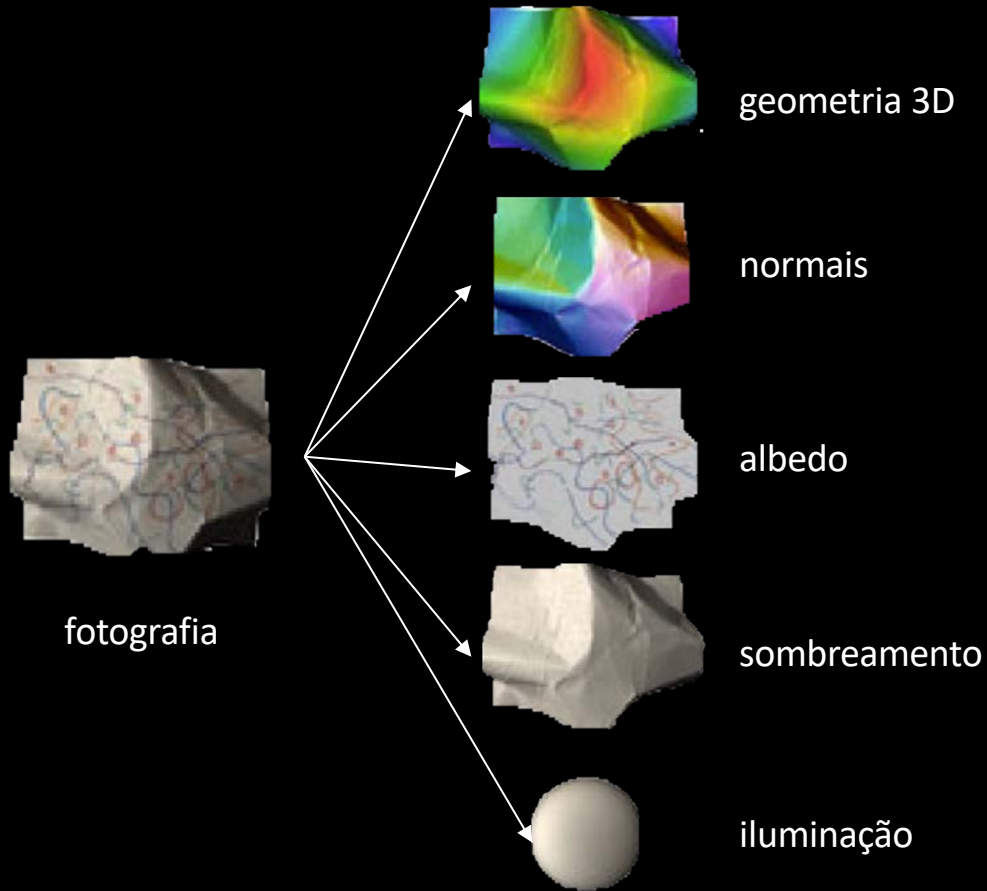
iluminação tradicional



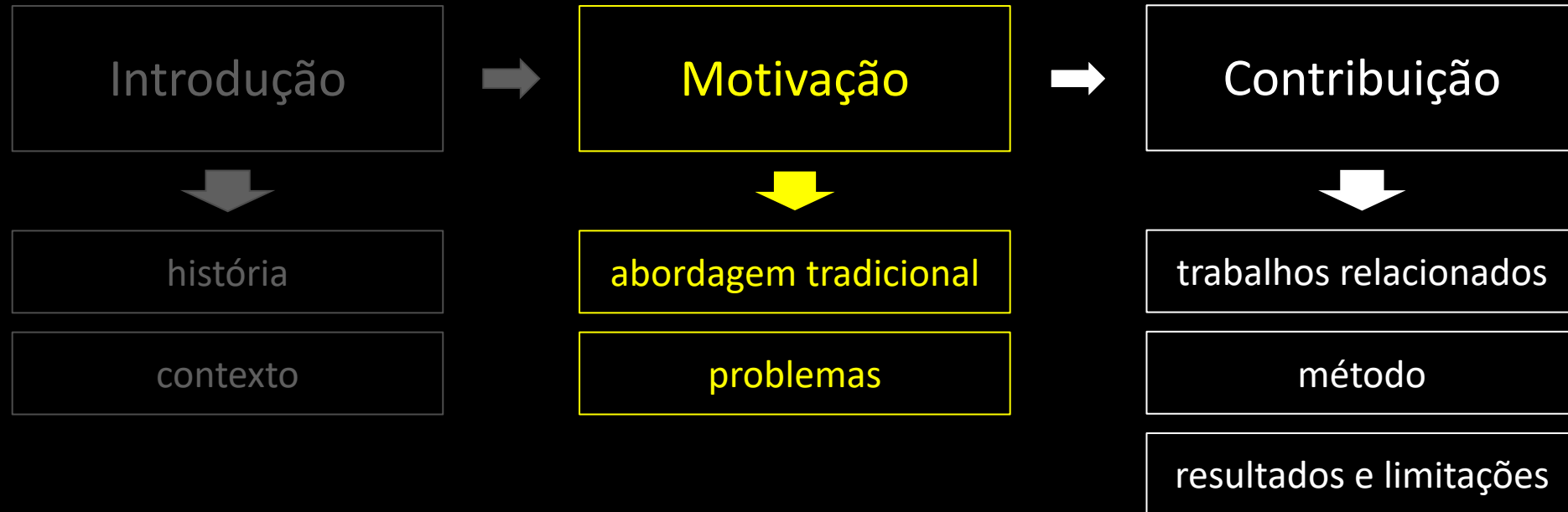
Image-Based Lighting (IBL)

Precisa mesmo de tudo isso?

Contexto: imagens intrínsecas e o “gaffer’s problem”



Estrutura



Abordagem tradicional: geometria e câmera

1. Estimativa de geometria da cena
e.g., Hold-Geoffroy, 2023
2. Posicionamento de objetos
providenciado pelo usuário
3. Estimativa de iluminação HDR
e.g., Hold-Geoffroy, 2017



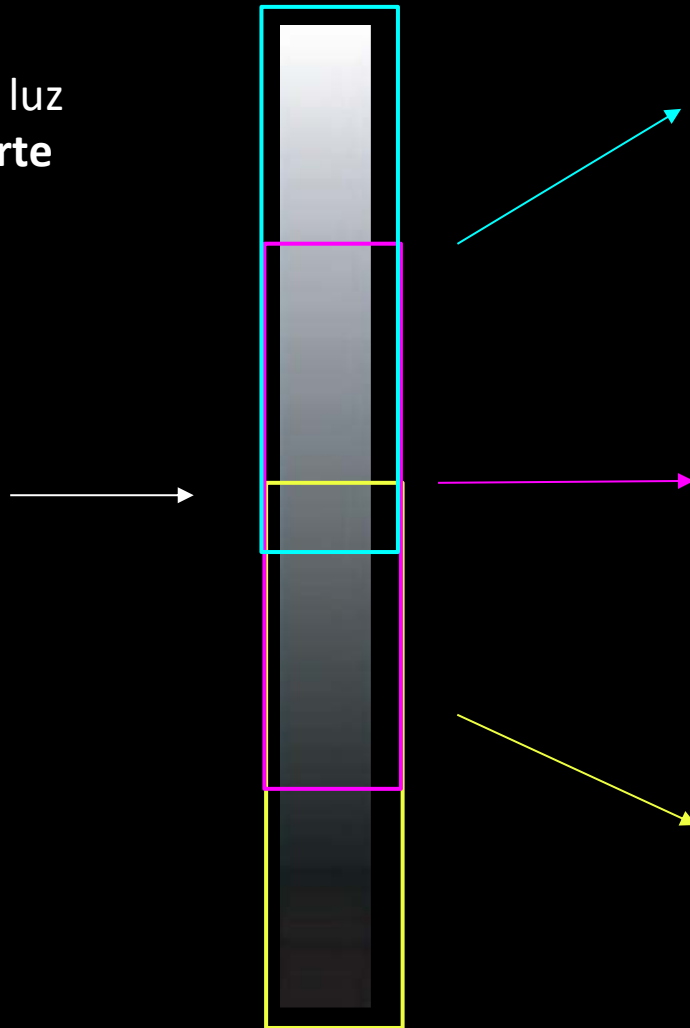
Abordagem tradicional: HDR



Fonte de luz
muito forte



cena com iluminação irregular



intensidades



partes mais claras

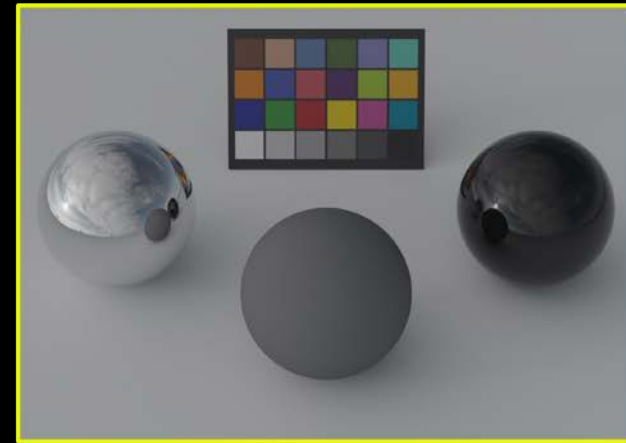
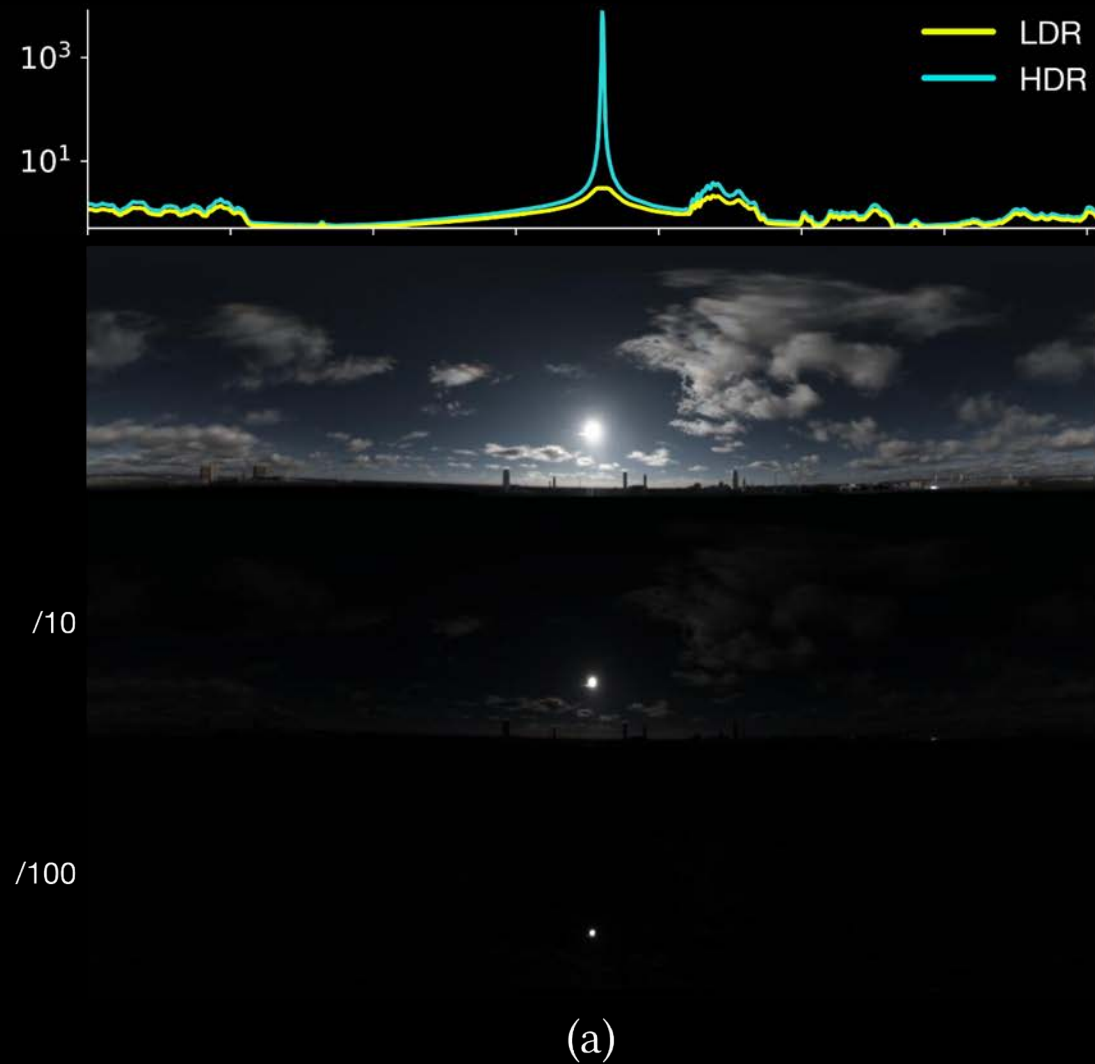


intensidades médias

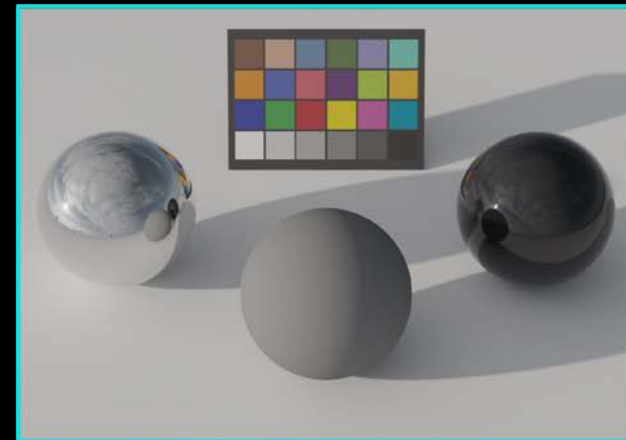


parte mais escuras

Abordagem tradicional: luz e sombras com HDR



(b)



(c)

Abordagem tradicional: iluminação e IBL

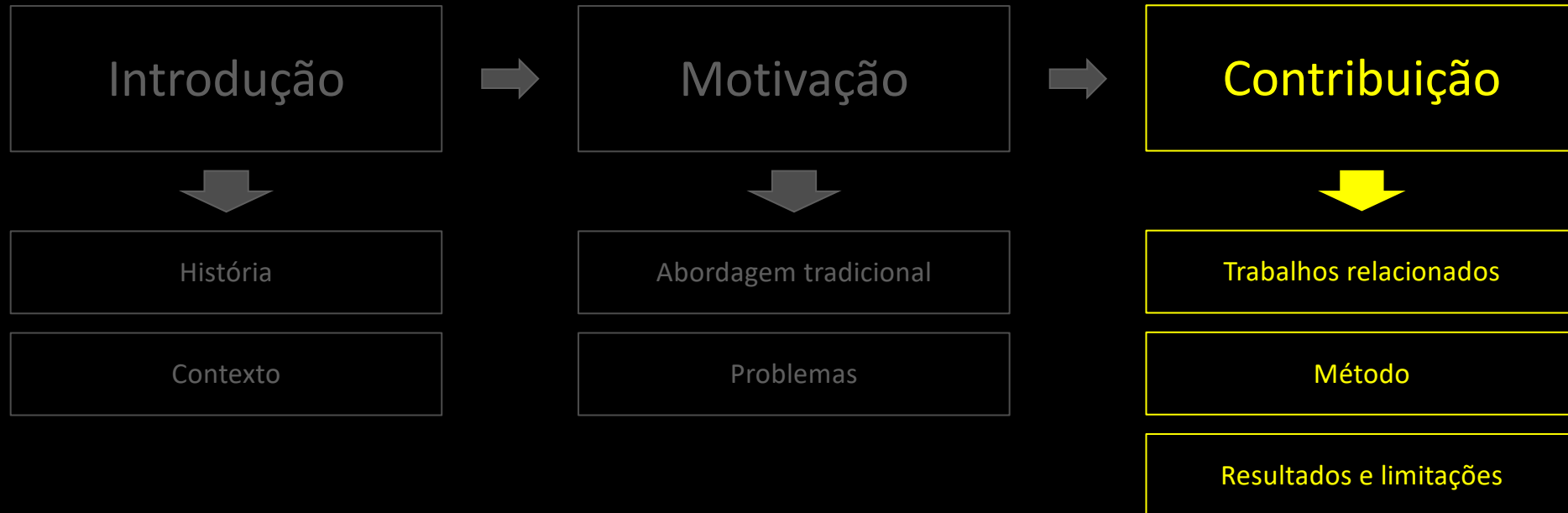
1. Estimativa de geometria da cena
e.g., Hold-Geoffroy, 2023
2. Posicionamento de objetos
providenciado pelo usuário
3. Estimativa de iluminação HDR
e.g., Hold-Geoffroy, 2017
4. IBL e renderização diferencial
Debevec, 1998
5. Ajuste de exposição
providenciado pelo usuário



Problemas



Estrutura



Trabalhos relacionados



Debevec, 1998
IBL e renderização diferencial



Chuang, 2003
edição de sombras



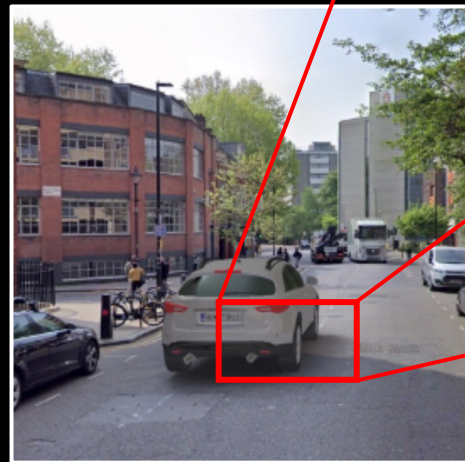
Karsch, 2011
anotações



Hold-Geoffroy, 2017
estimativa de iluminação



Nicolet, 2020
edição *multi-view*



Wang, 2022
iluminação *c/* variação espacial



Nosso objetivo: sombras melhores



Shadow Harmonization for Realistic Compositing

Lucas Valença, Jinsong Zhang, Michaël Gharbi, Yannick Hold-Geoffroy, Jean-François Lalonde

Método

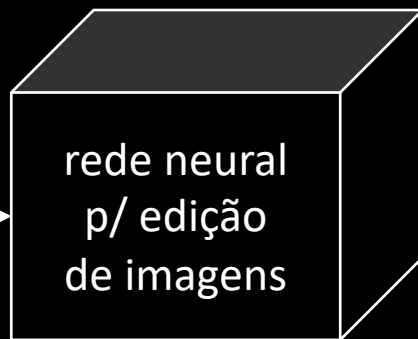


imagem de fundo

estimativa de luz e geometria



objeto renderizado



resultado

Método: visão geral

Entradas

1. *background* LDR
2. objeto renderizado



Objetivos

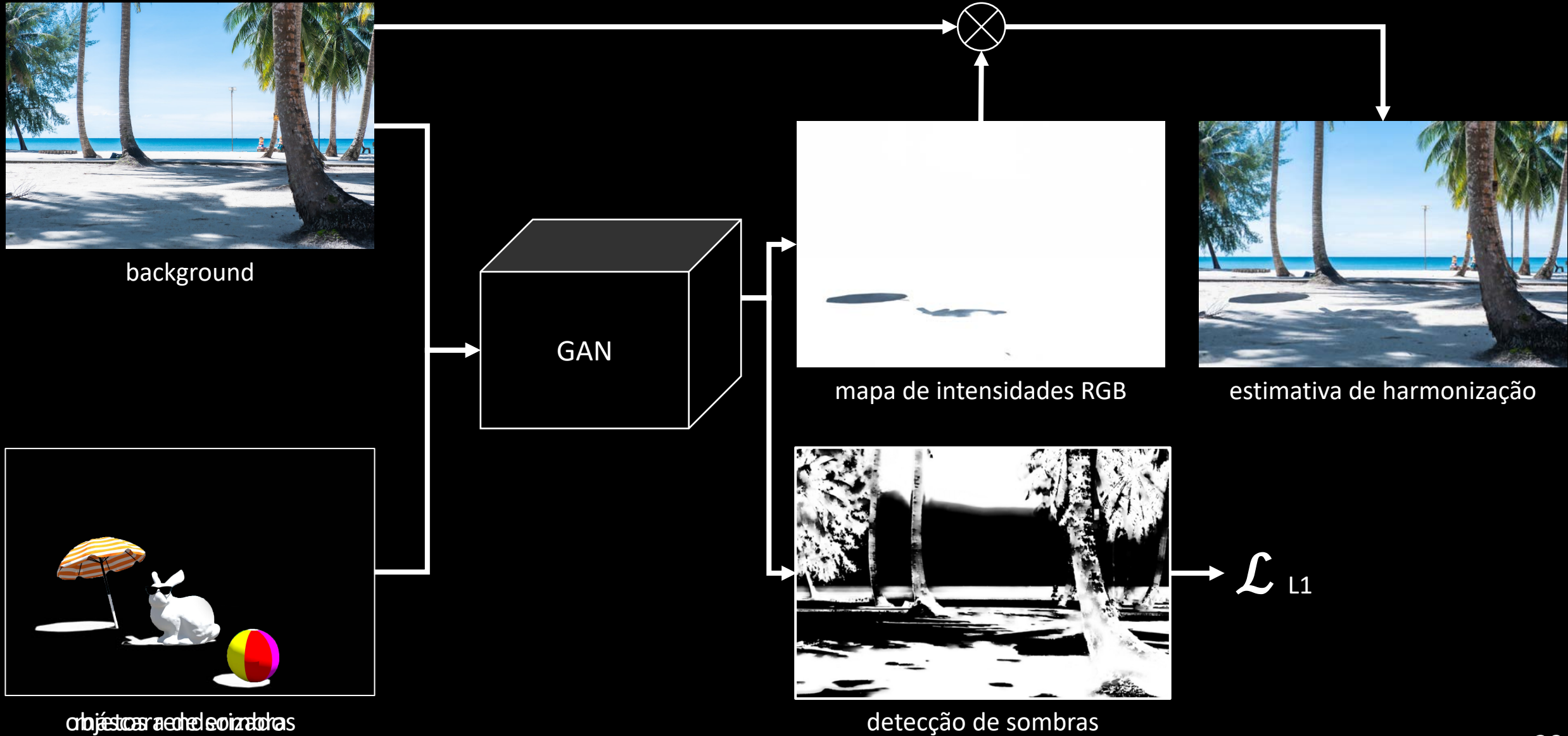
1. Harmonizar sombras virtuais em imagens de fundo reais
2. Re-projetar sombras sobre novos objetos



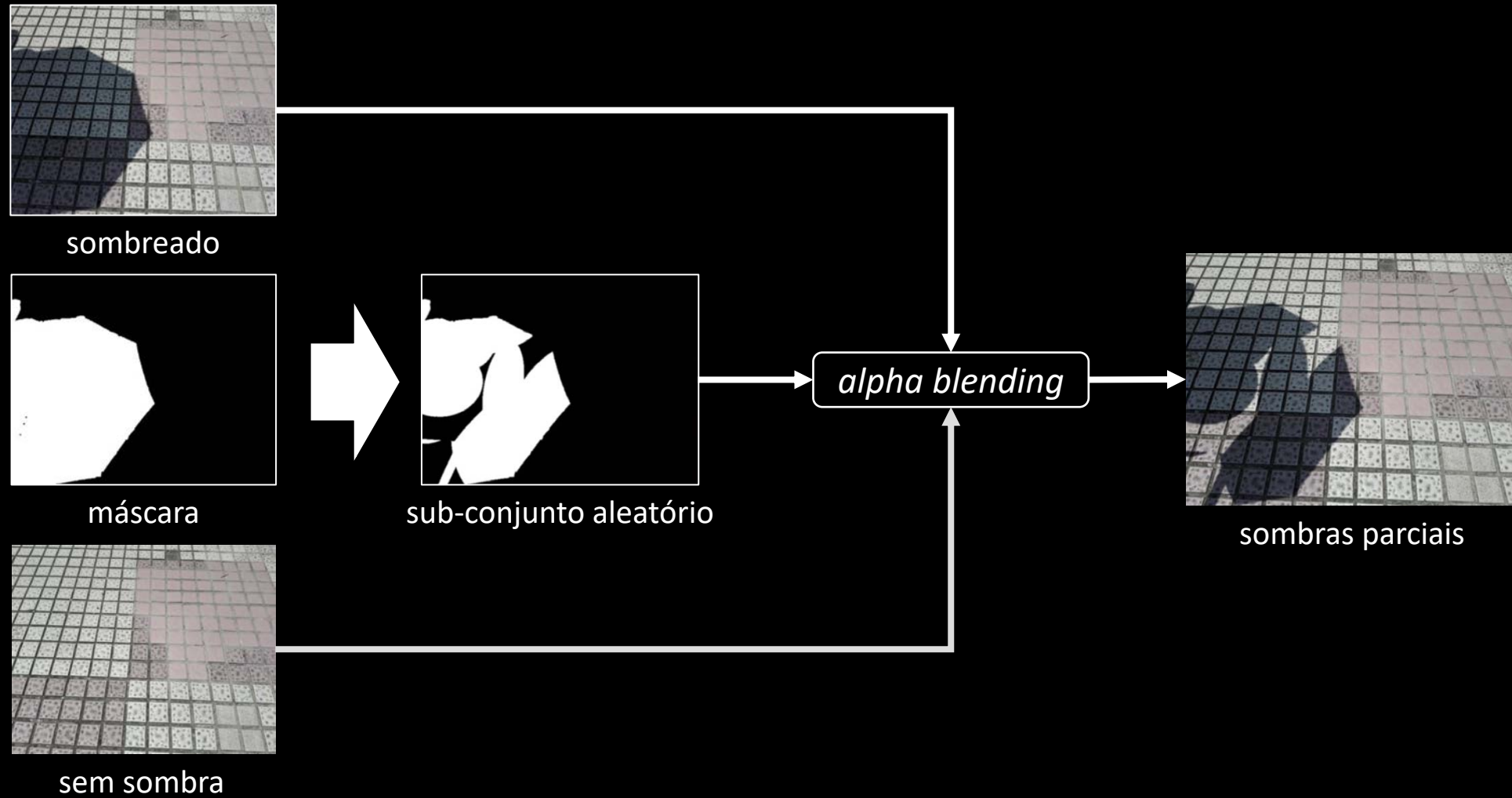
*foco em
iluminação
outdoors



Método: harmonização



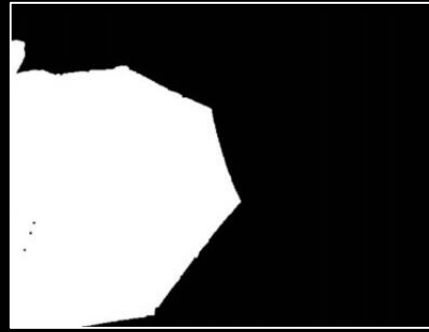
Método: dados reais e *online data augmentation*



Método: tipos de *dataset*



imagem de fundo



máscara para
sombrear



objetivo de
harmonização



objetivo de detecção

2 types
of
dataset



real



synthetic



imagem de fundo



máscara para
sombrear

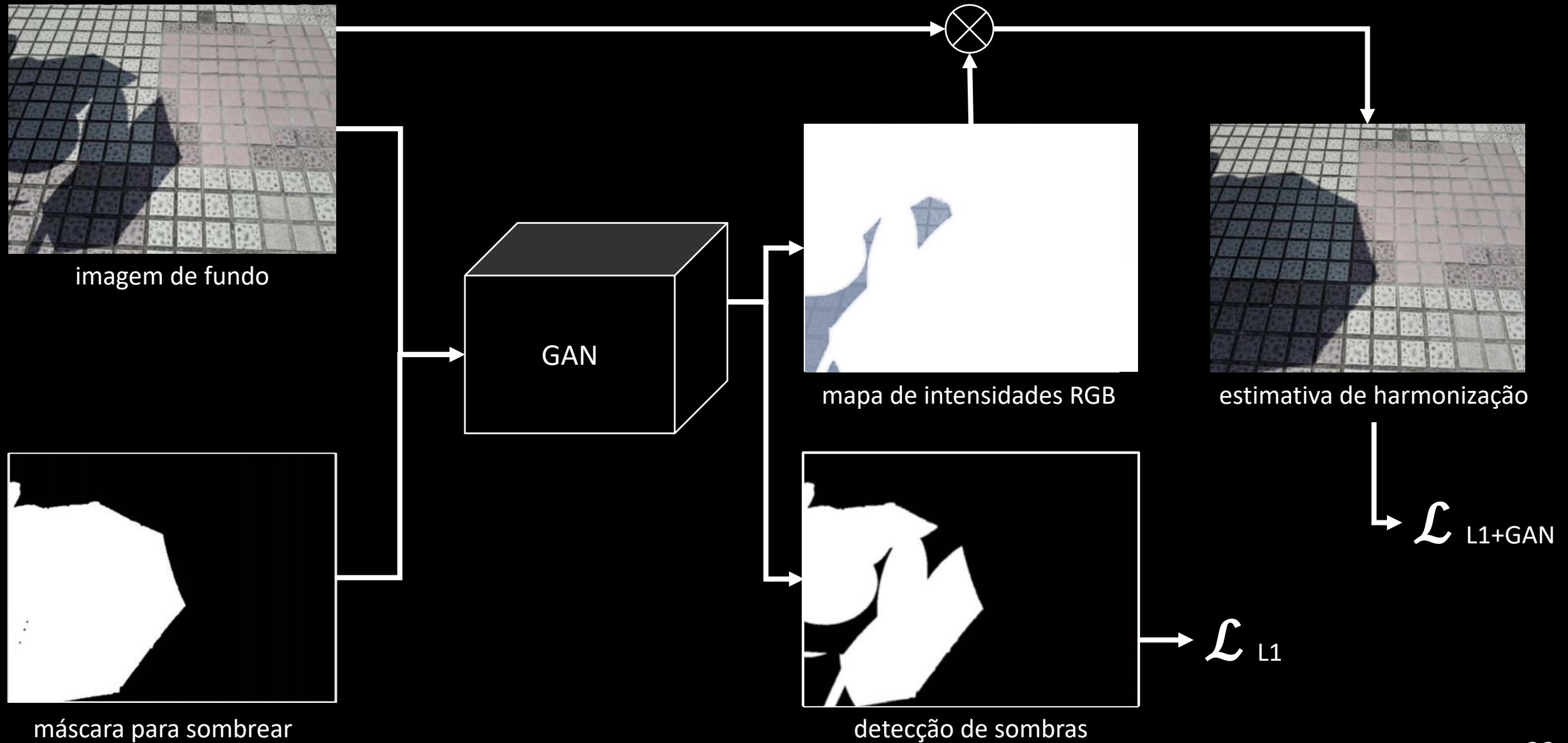


objetivo de
harmonização



objetivo de detecção

Método: treinamento da rede neural





Projetar sombras

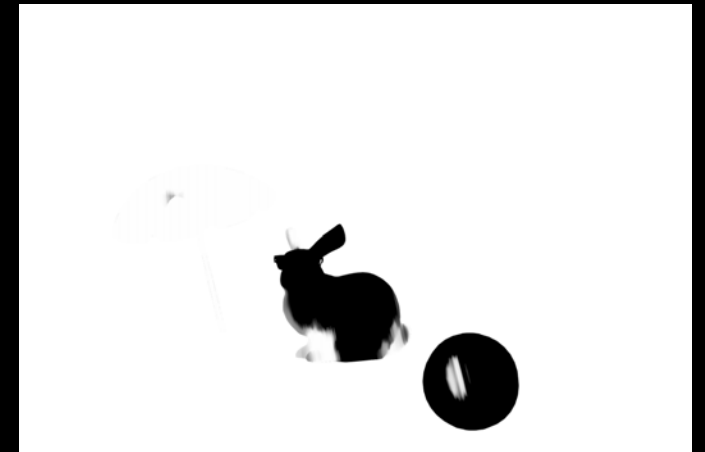
Método: deformação de sombras



sombras detectadas

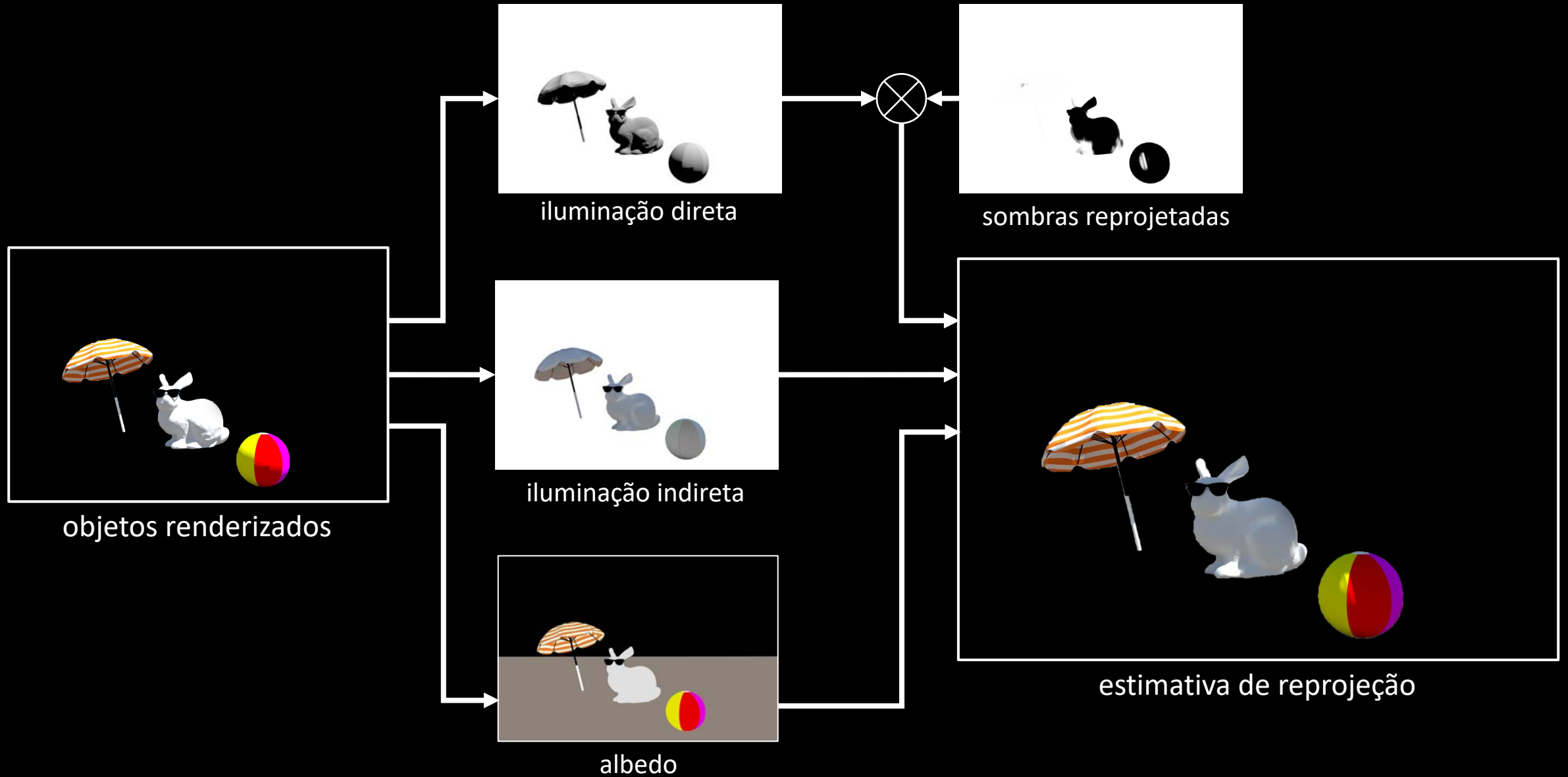


operador de deformação de sombras
Chuang, 2003



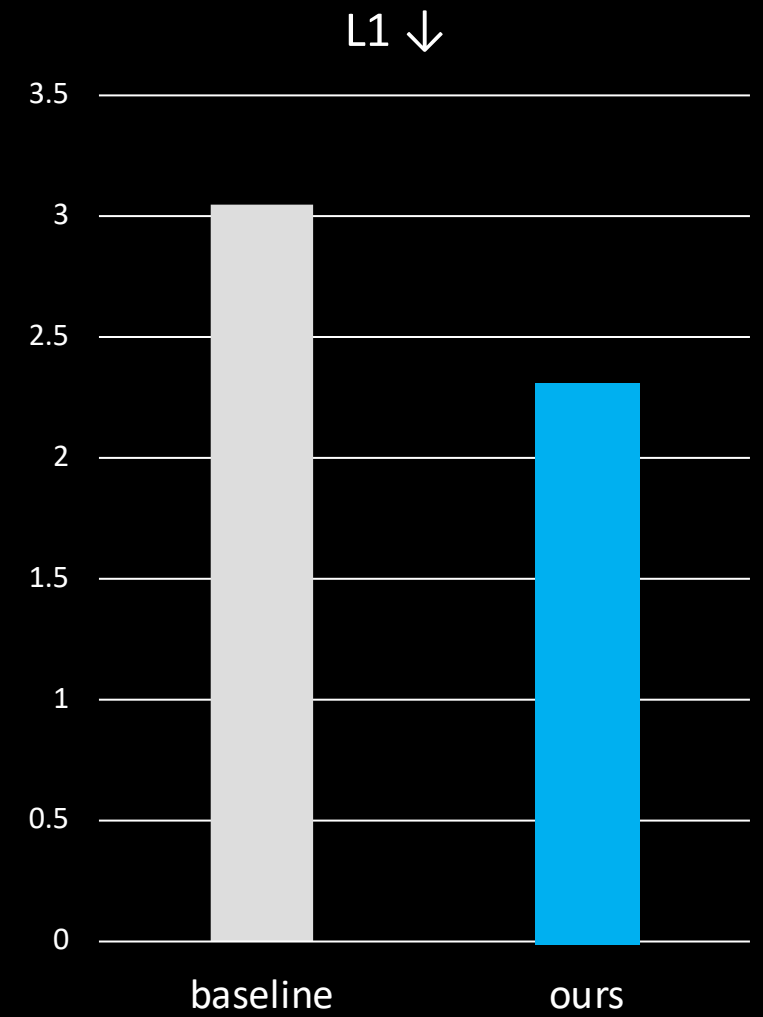
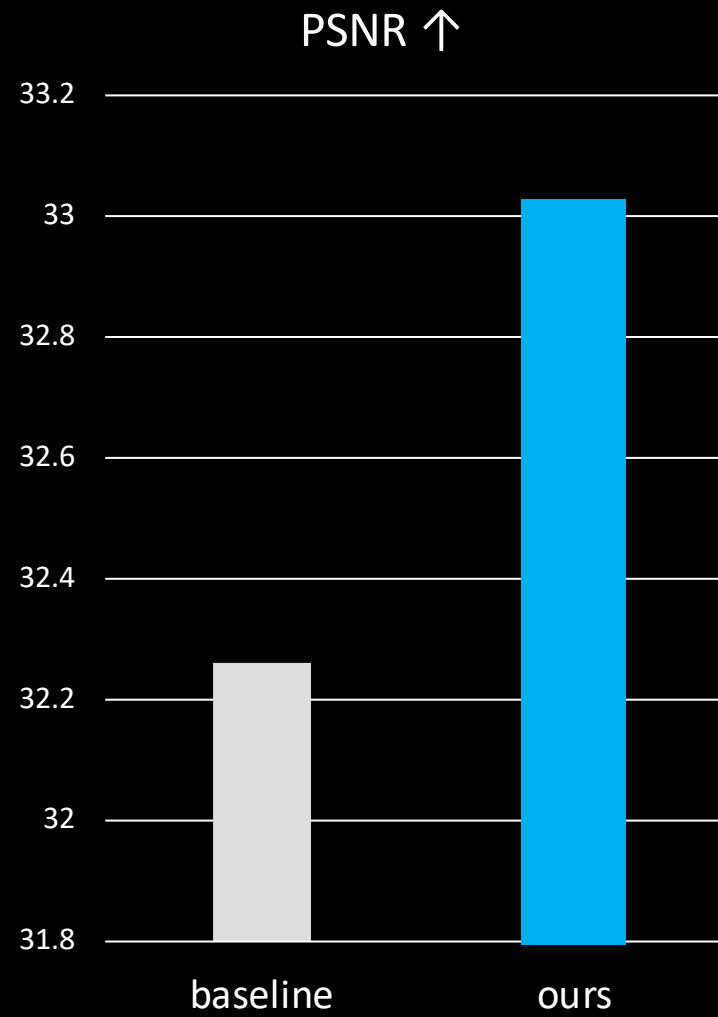
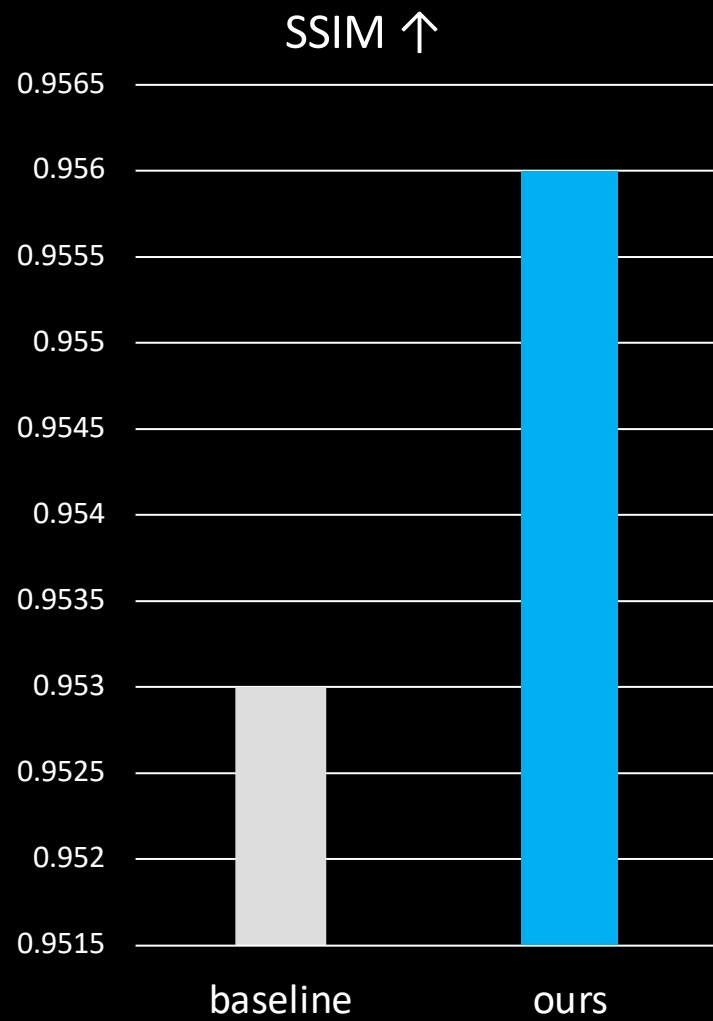
máscara de sombras reprojctadas

Método: corrigindo a iluminação direta



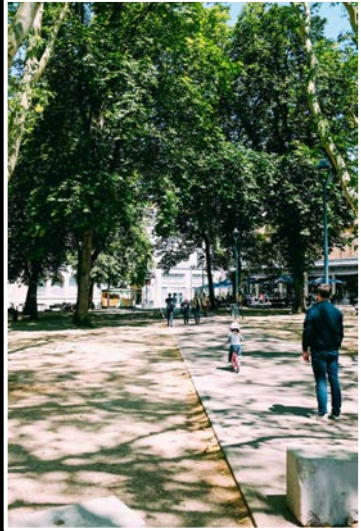
Resultados

Quantitativo: qualidade de imagem

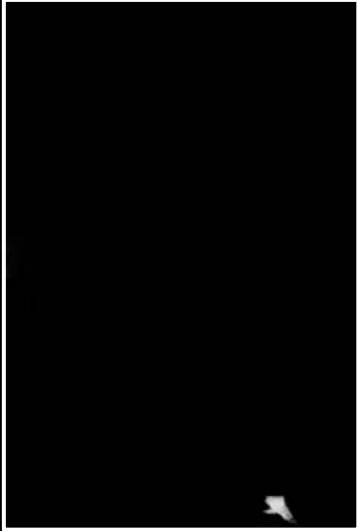


Qualitativo: detecção de sombras

input



MTMT
(Chen et al., 2020)



ours



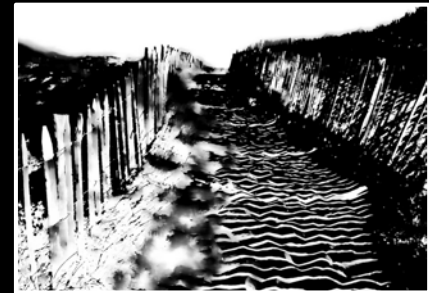
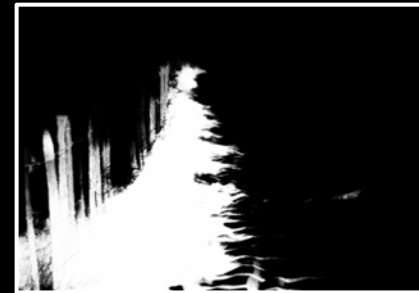
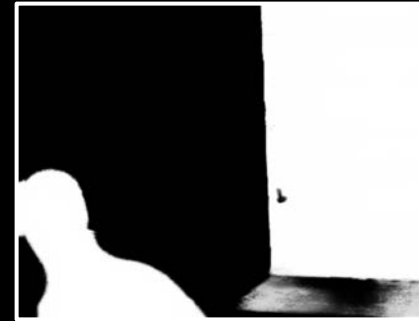
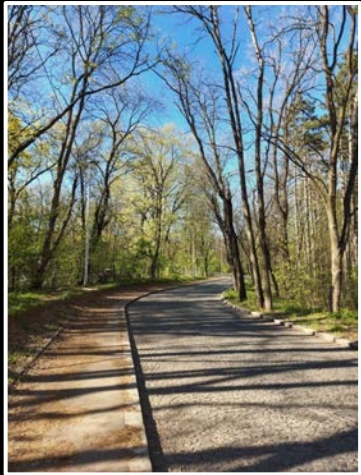
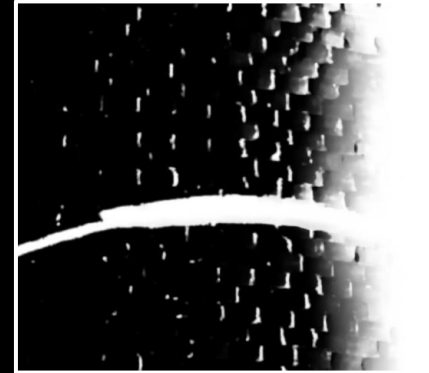
input



MTMT
(Chen et al., 2020)



ours



Qualitativo: dataset DESOBA

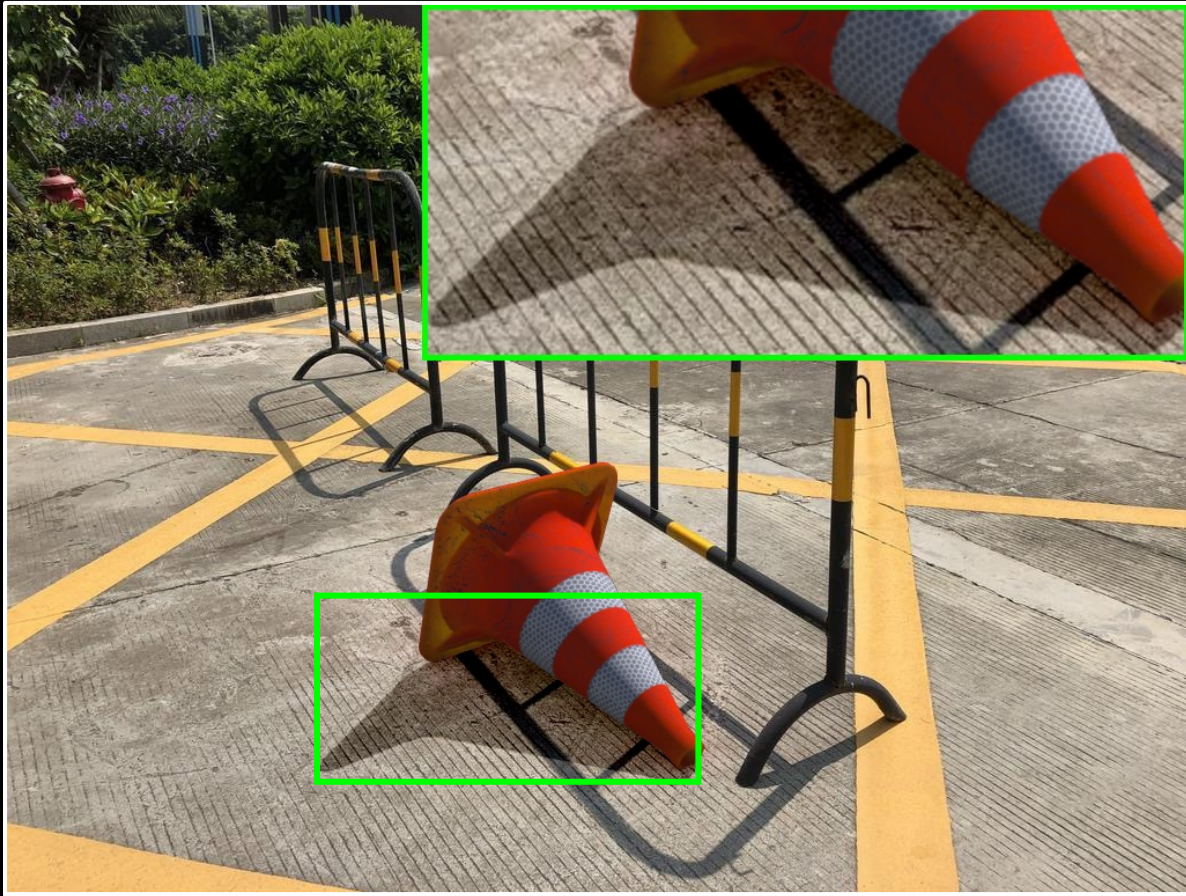


input

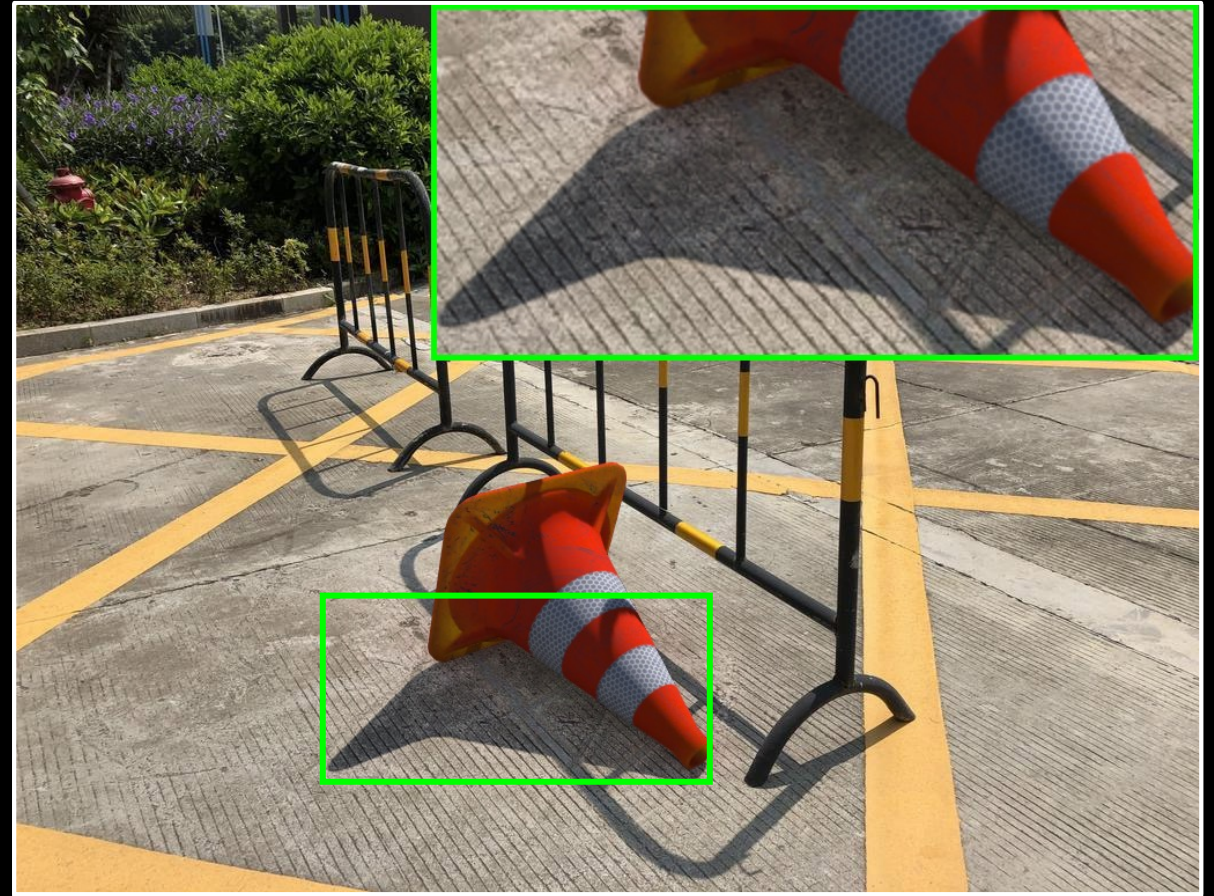


traditional IBL
Debevec, 1998

Qualitativo: dataset DESOBA

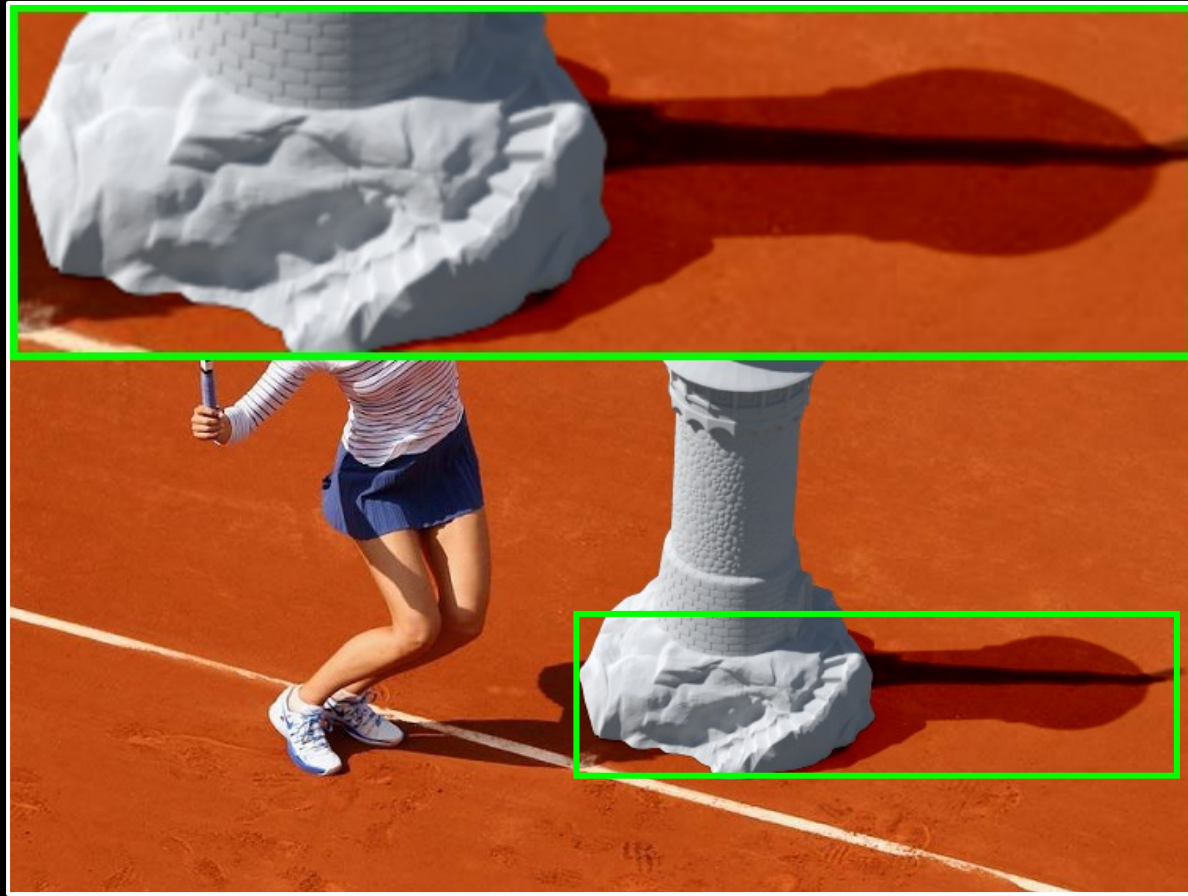


input

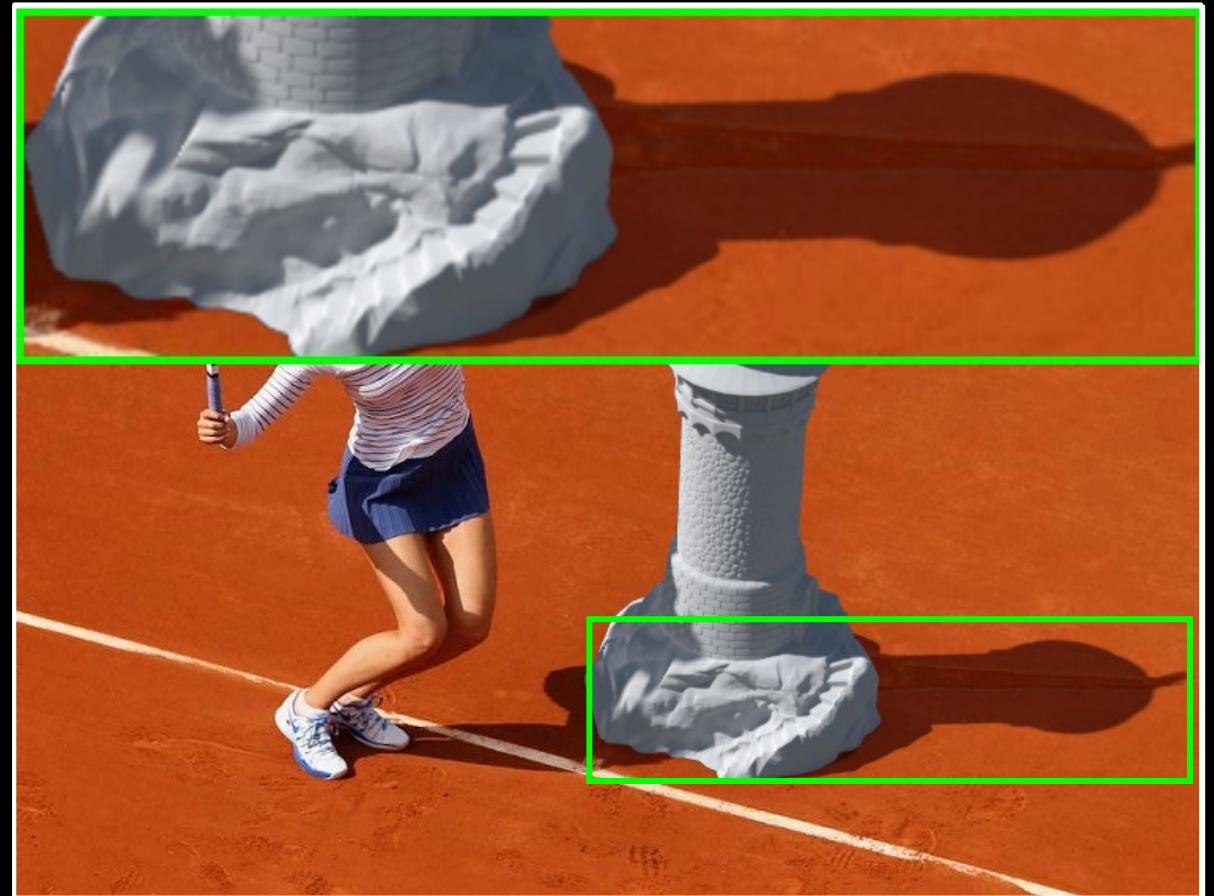


traditional IBL
Debevec, 1998

Qualitativo: dataset SBU

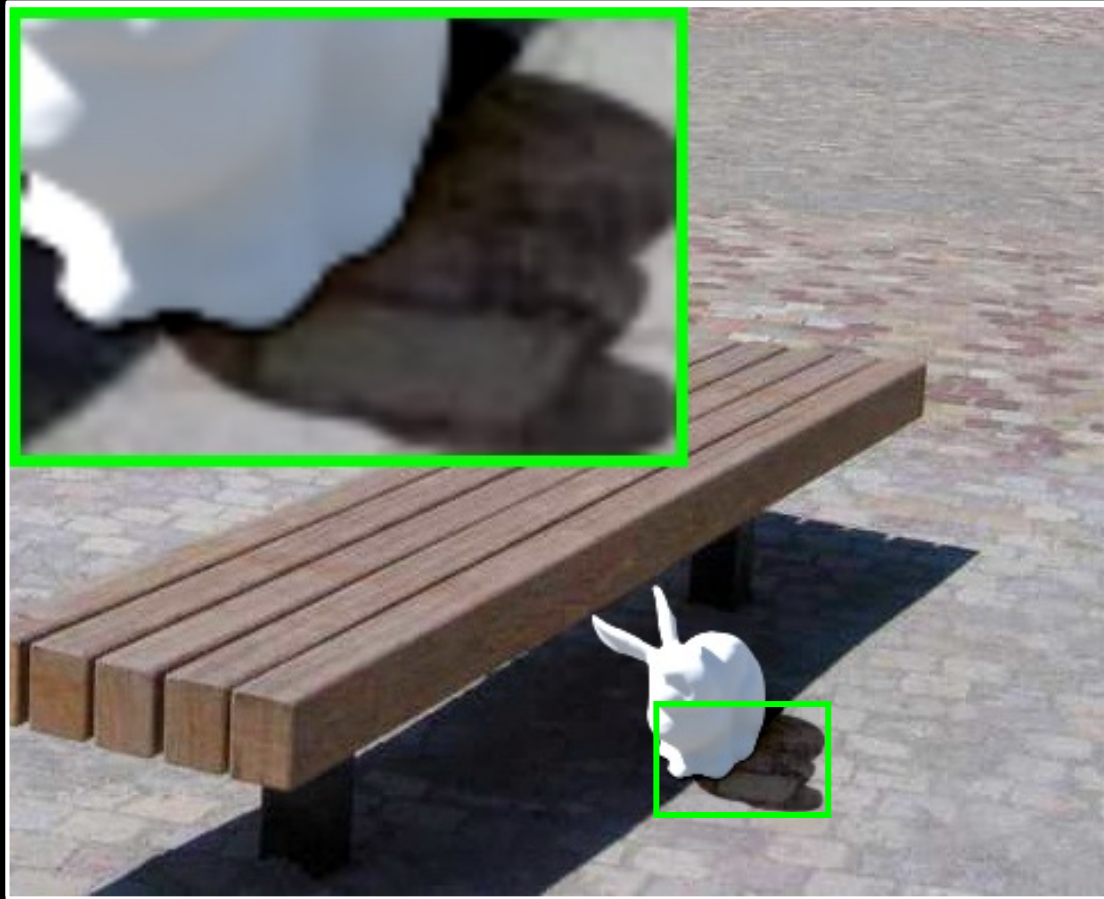


input

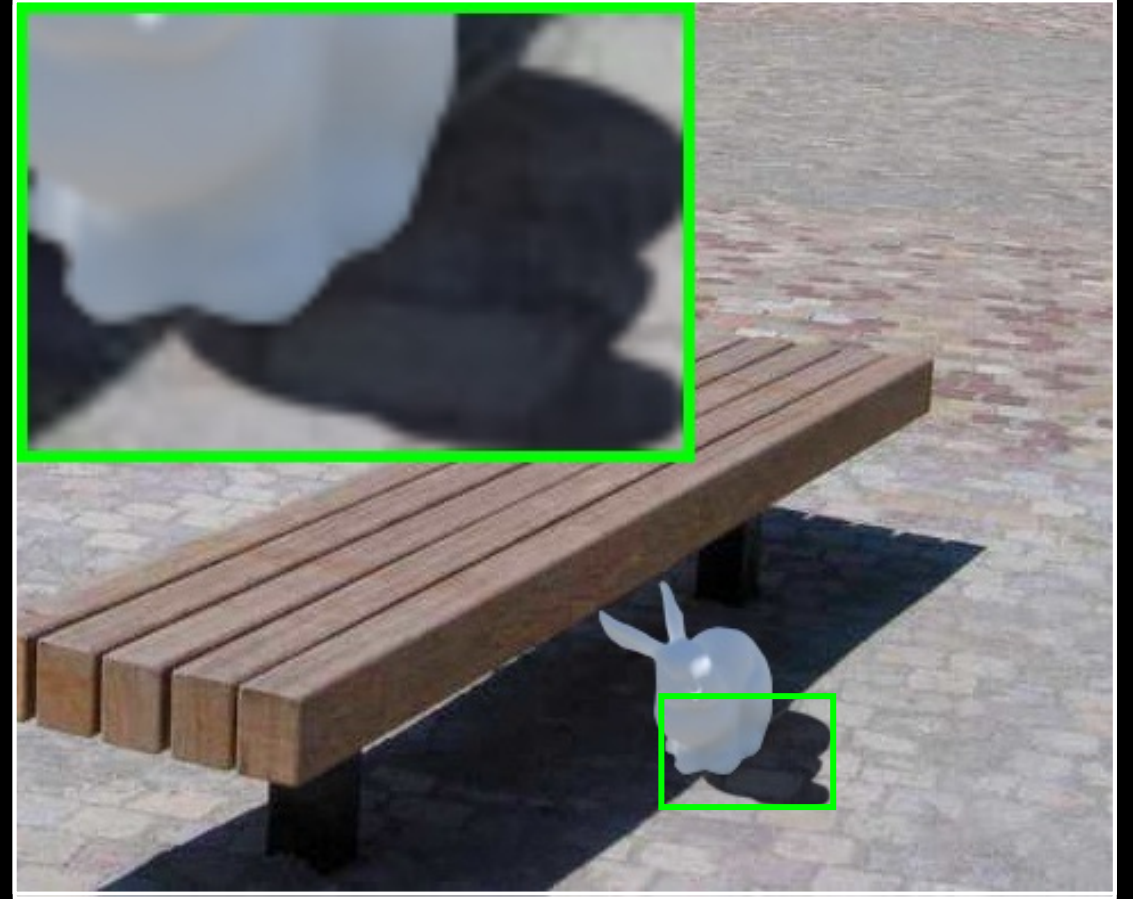


traditional IBL
Debevec, 1998

Qualitativo: dataset SBU

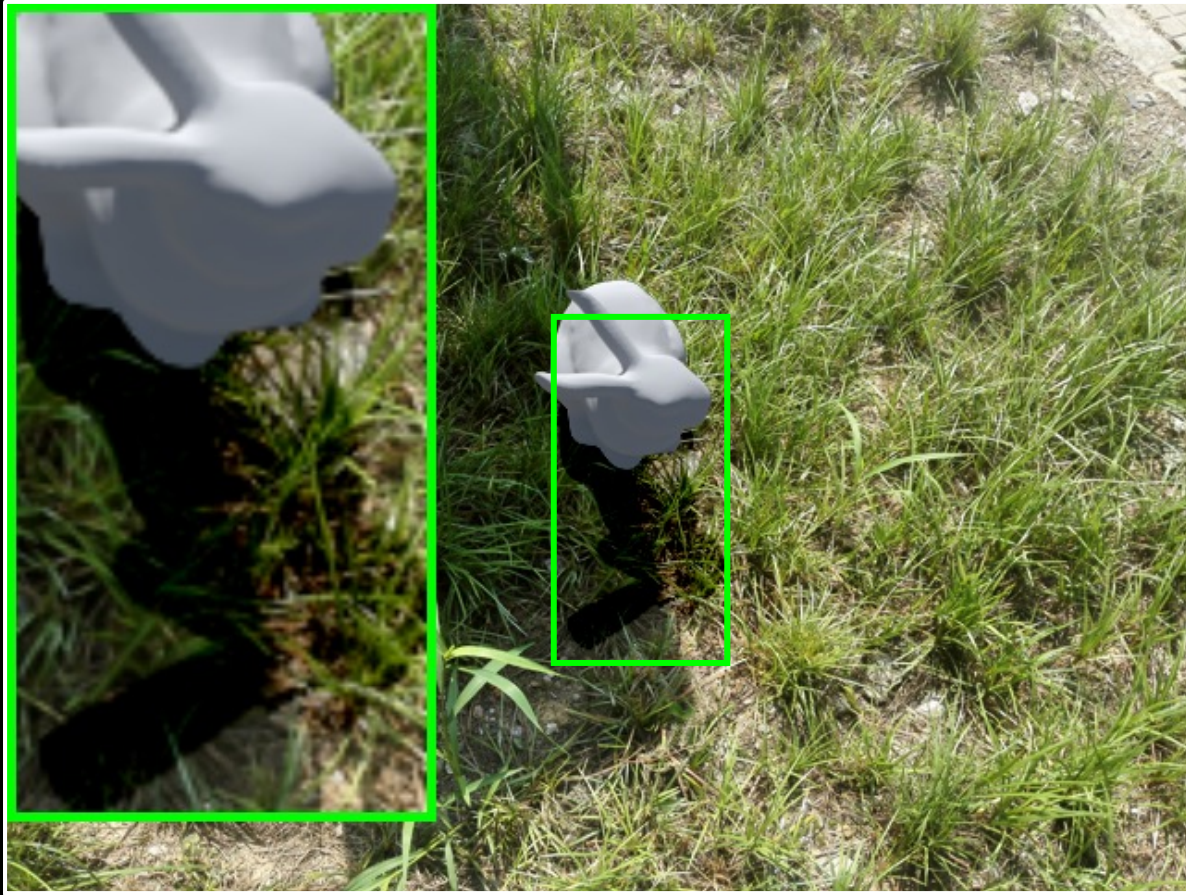


input

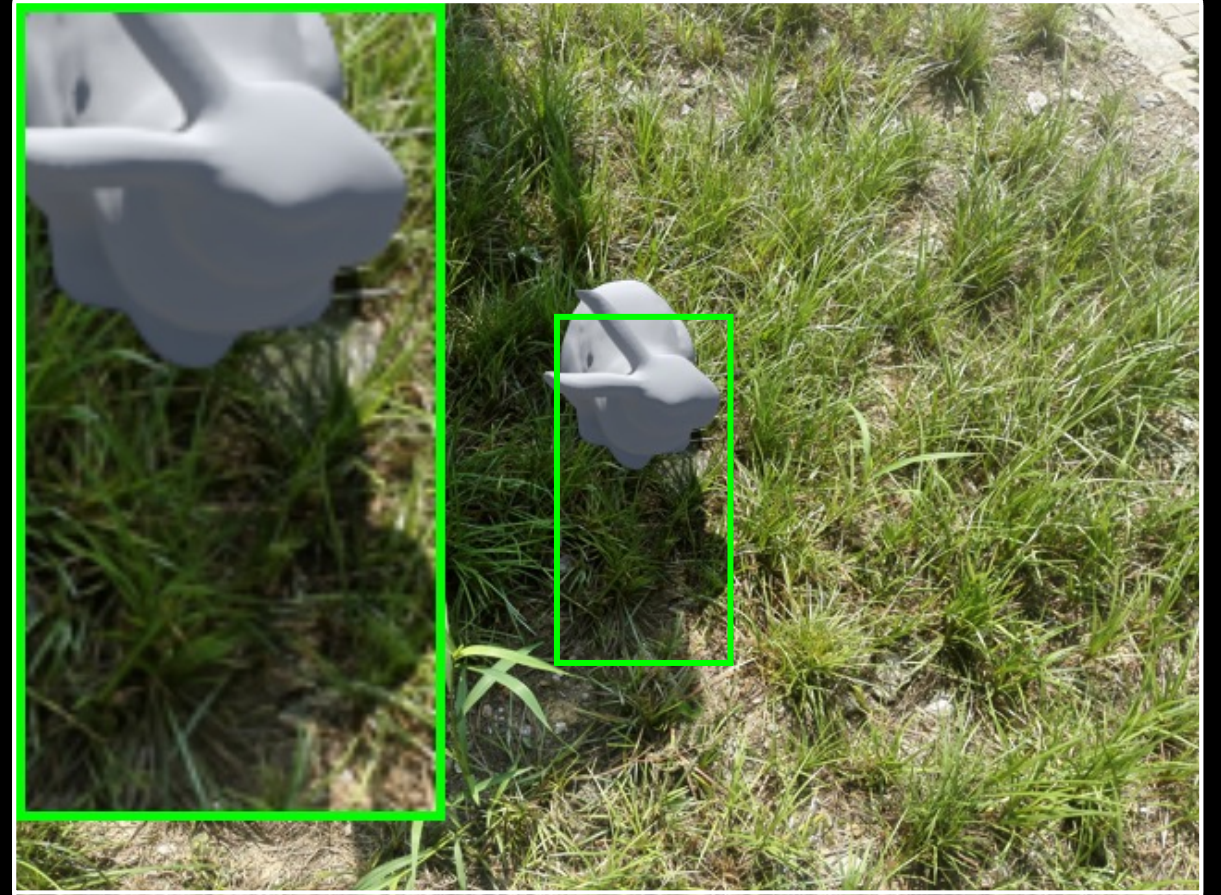


traditional IBL
Debevec, 1998

Qualitativo: dataset ISTD

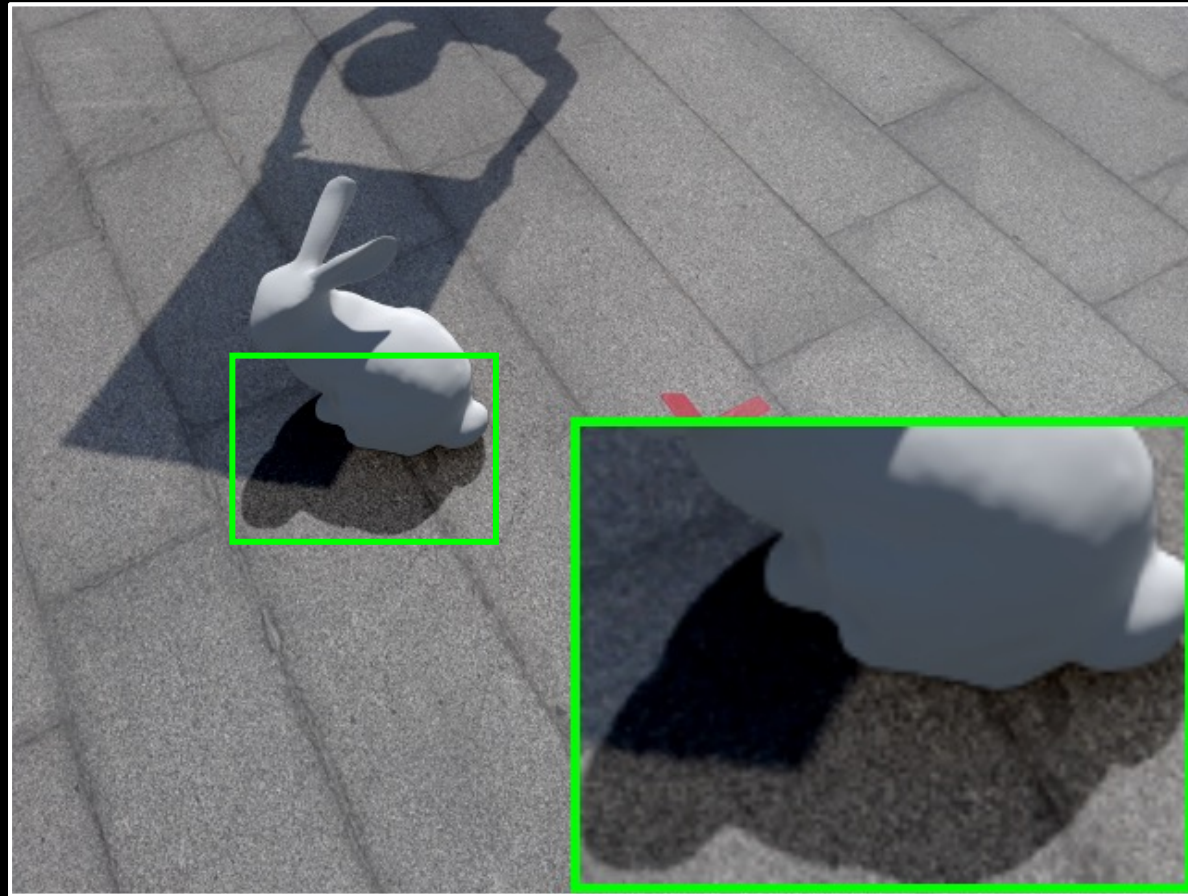


input

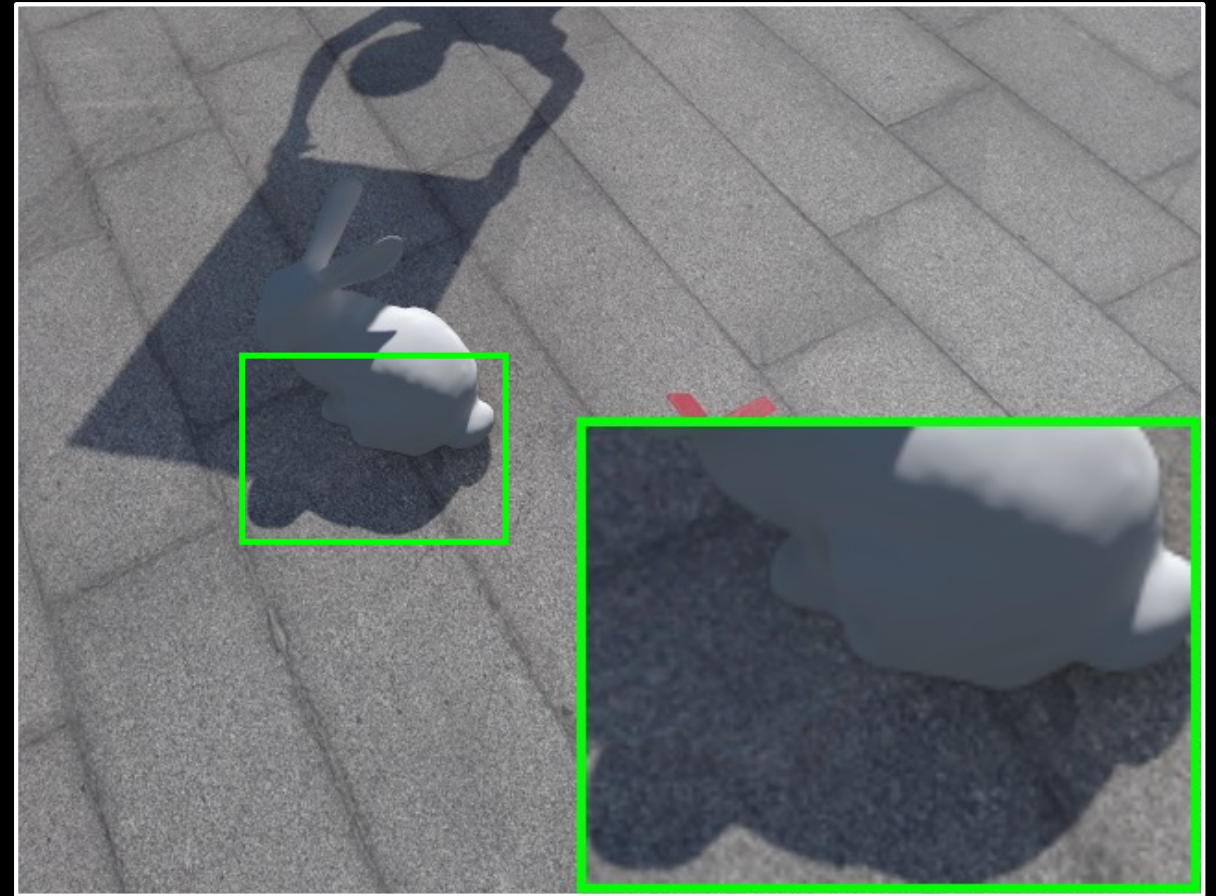


traditional IBL
Debevec, 1998

Qualitativo: dataset ISTD



input



traditional IBL
Debevec, 1998

Qualitativo: animações de fundo estático

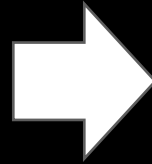


Limitações

- Somente cenas “outdoor”
- Dependência em métodos externos
- Sombras indo além das bordas da fotografia



Conclusão



Ficou mais fácil fazer montagens realistas sem ter habilidades artísticas!

Obrigado pela atenção!

artigo, código, datasets e outros materiais suplementares
disponíveis no link (ou pelo QR code)

<https://lvsn.github.io/shadowcompositing>

