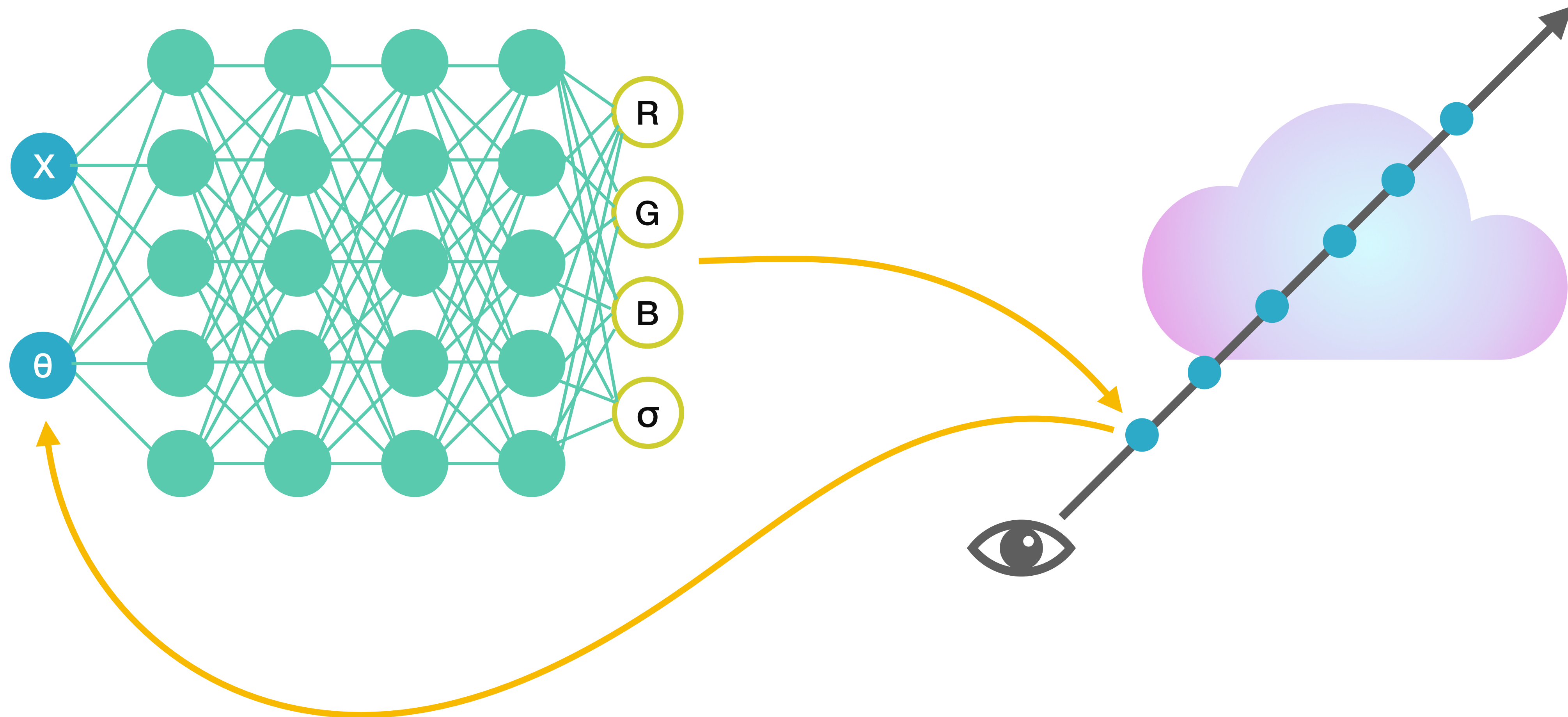


# Generalizing and Speeding up Neural Radiance Fields

Matt Tancik

# NeRF in under a minute





# The never-ending list of NeRF limitations

- ▶ Expensive / slow to train
- ▶ Expensive / slow to render
- ▶ Sensitive to sampling strategy
- ▶ Does not generalize between scenes
- ▶ Sensitive to pose accuracy
- ▶ Assumes static scene
- ▶ Assumes static lighting and camera focus
- ▶ Not relightable
- ▶ Not deformable

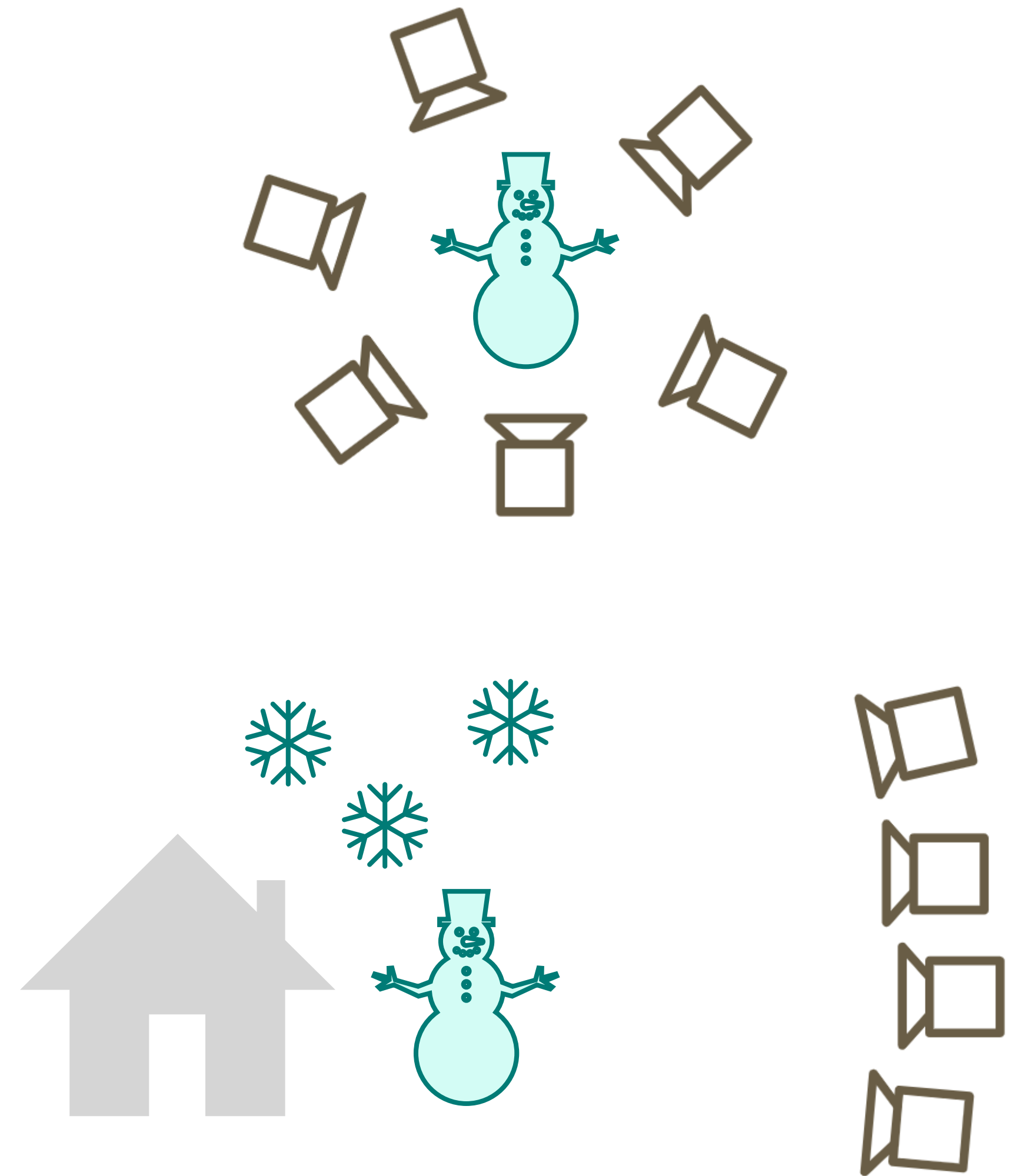
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Pose noise increased

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- ▶ Expensive / slow to render
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- ▶ Assumes static lighting and camera focus
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# The never-ending list of NeRF limitations

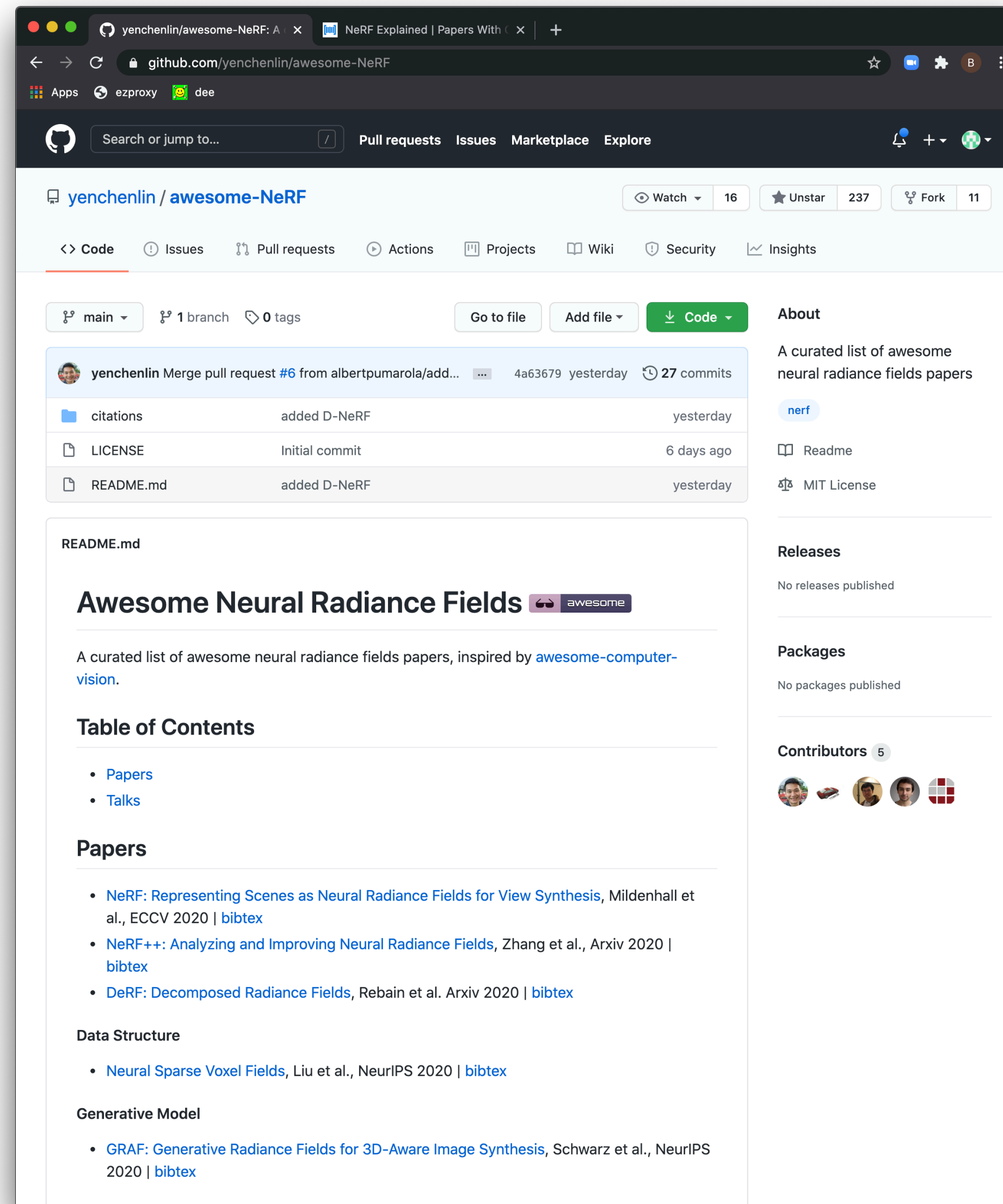
- ▶ Expensive / slow to train
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# The never-ending list of NeRF extensions



<https://github.com/yenchelin/awesome-NeRF>

# The never-ending list of NeRF limitations

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- ▶ Expensive / slow to render
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- ▶ Assumes static lighting and camera focus
- ▶ Not relightable
- ▶ Not deformable

# Learned Initializations for Optimizing Coordinate-Based Neural Representations

Matthew Tancik<sup>\*1</sup>

Ben Mildenhall<sup>\*1</sup>

Terrance Wang<sup>1</sup>

Divi Schmidt<sup>1</sup>

Pratul P. Srinivasan<sup>2</sup>

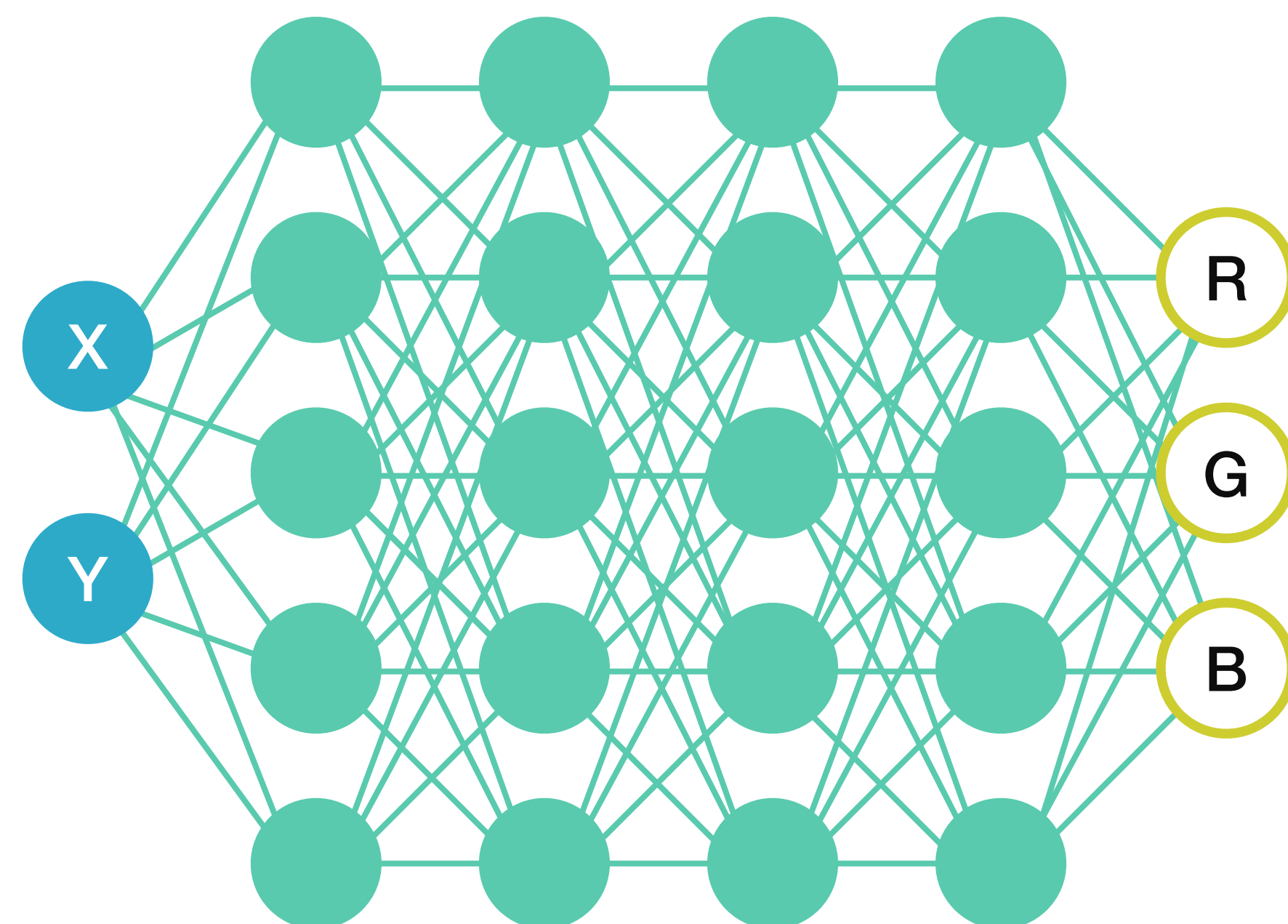
Jonathan T. Barron<sup>2</sup>

Ren Ng<sup>1</sup>

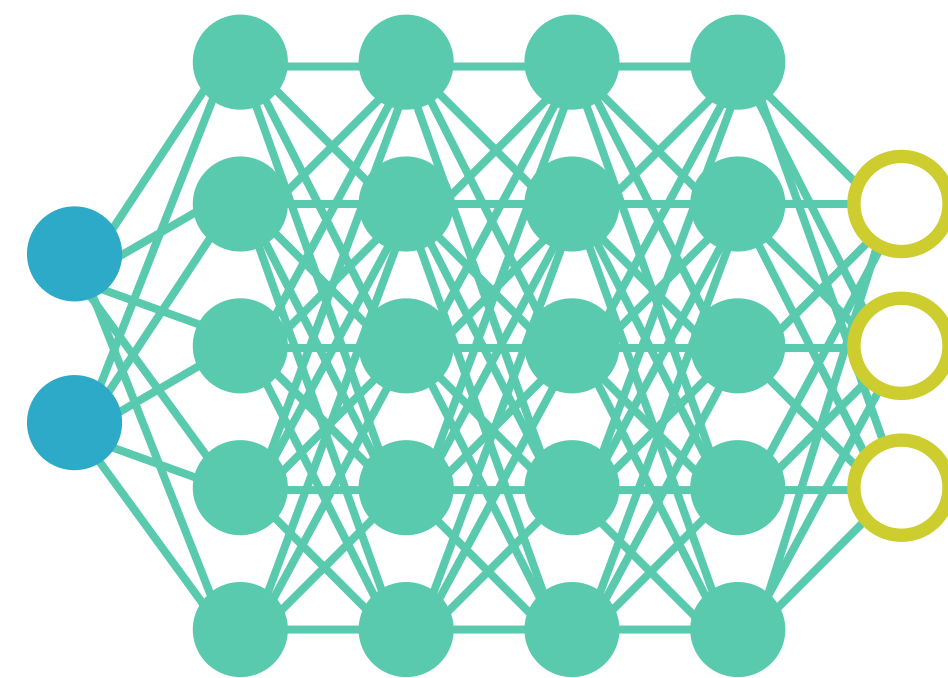
<sup>\*</sup> Denotes Equal Contribution

<sup>1</sup>UC Berkeley

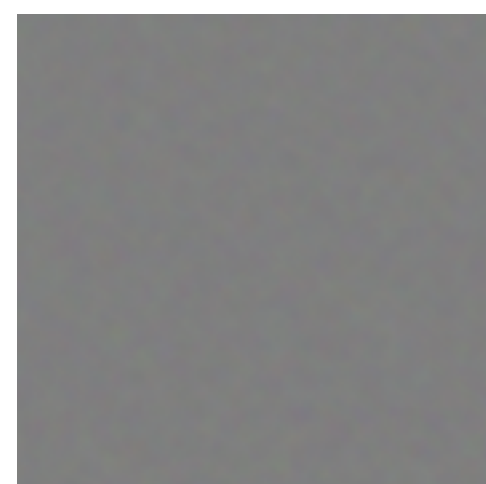
<sup>2</sup>Google Research



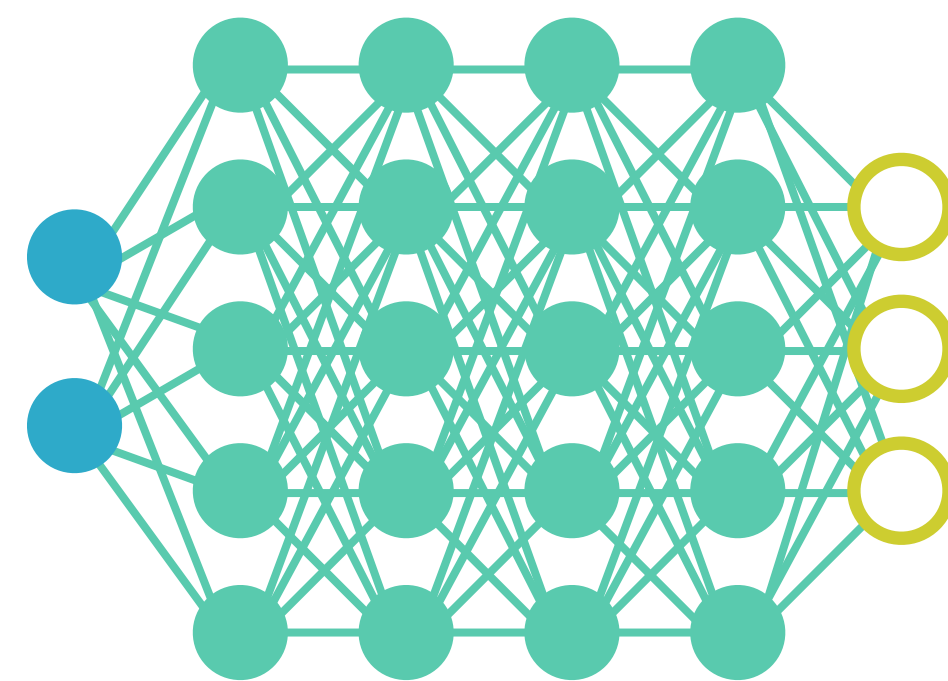
$f_{\theta}$



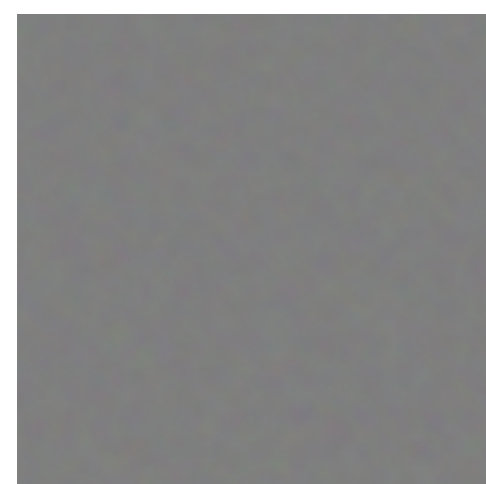
$f_{\theta}$



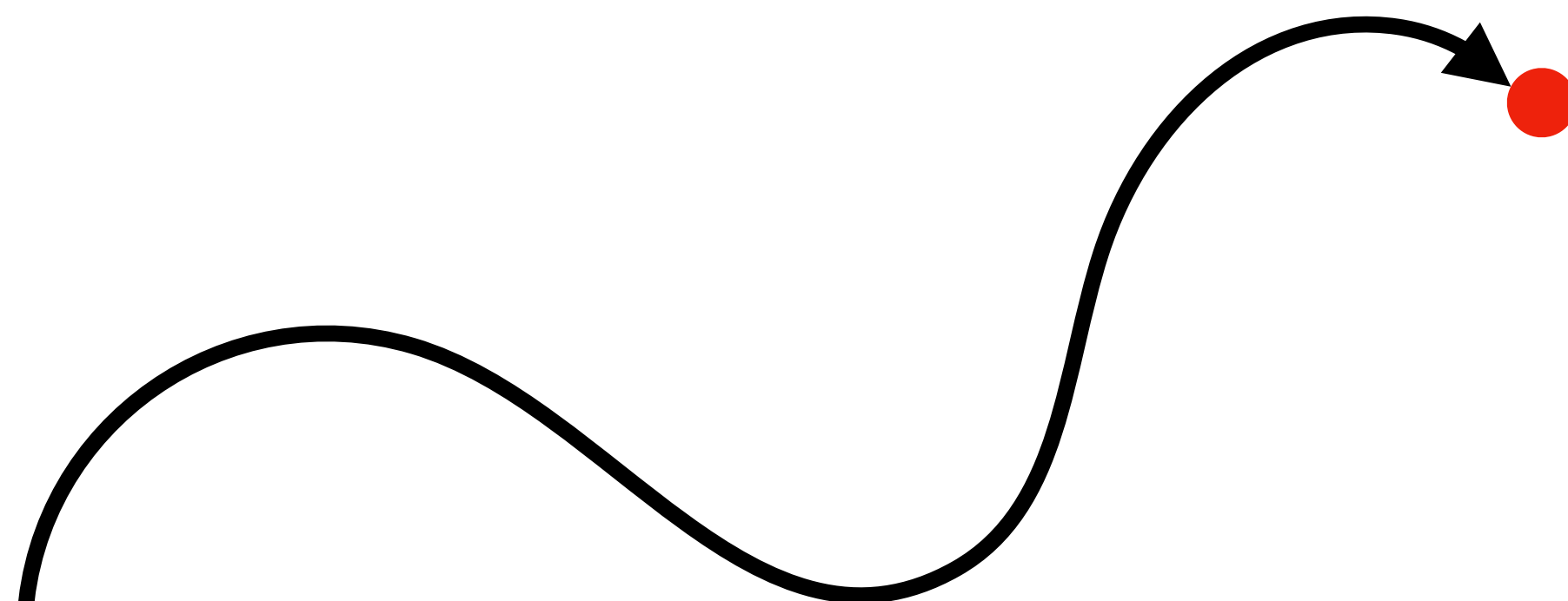
$\theta_0$

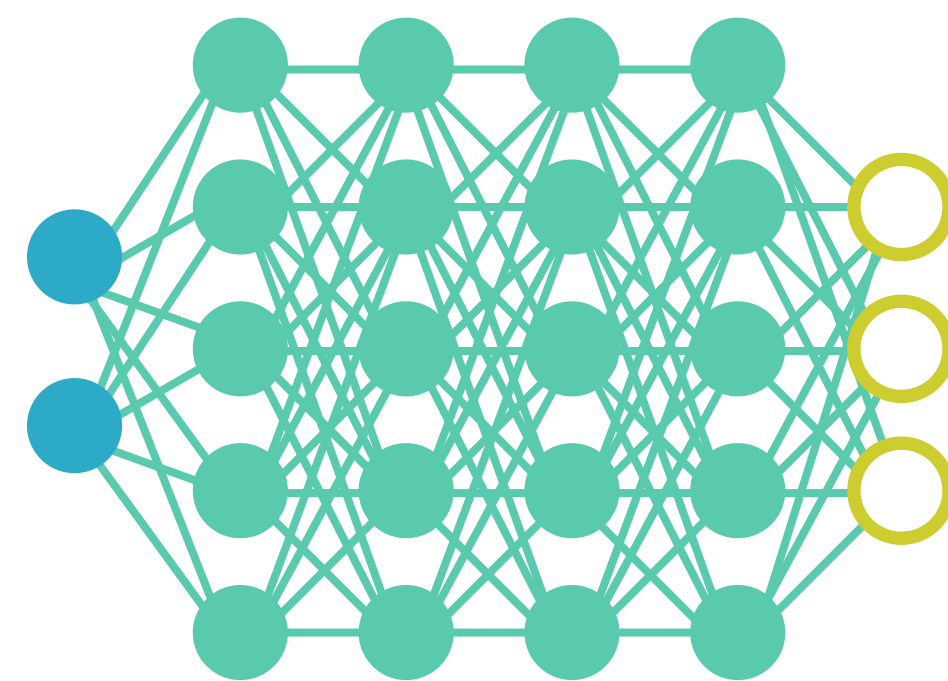


$f_{\theta}$

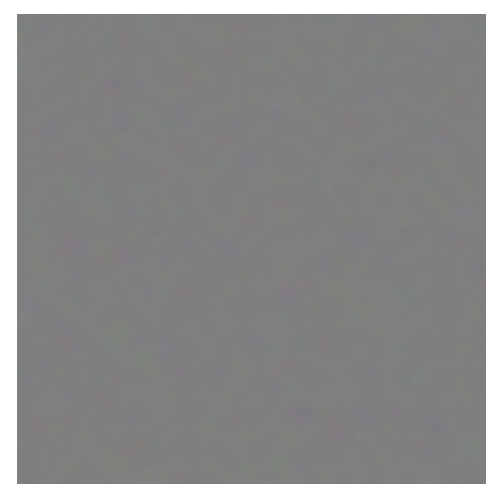


$\theta_0$

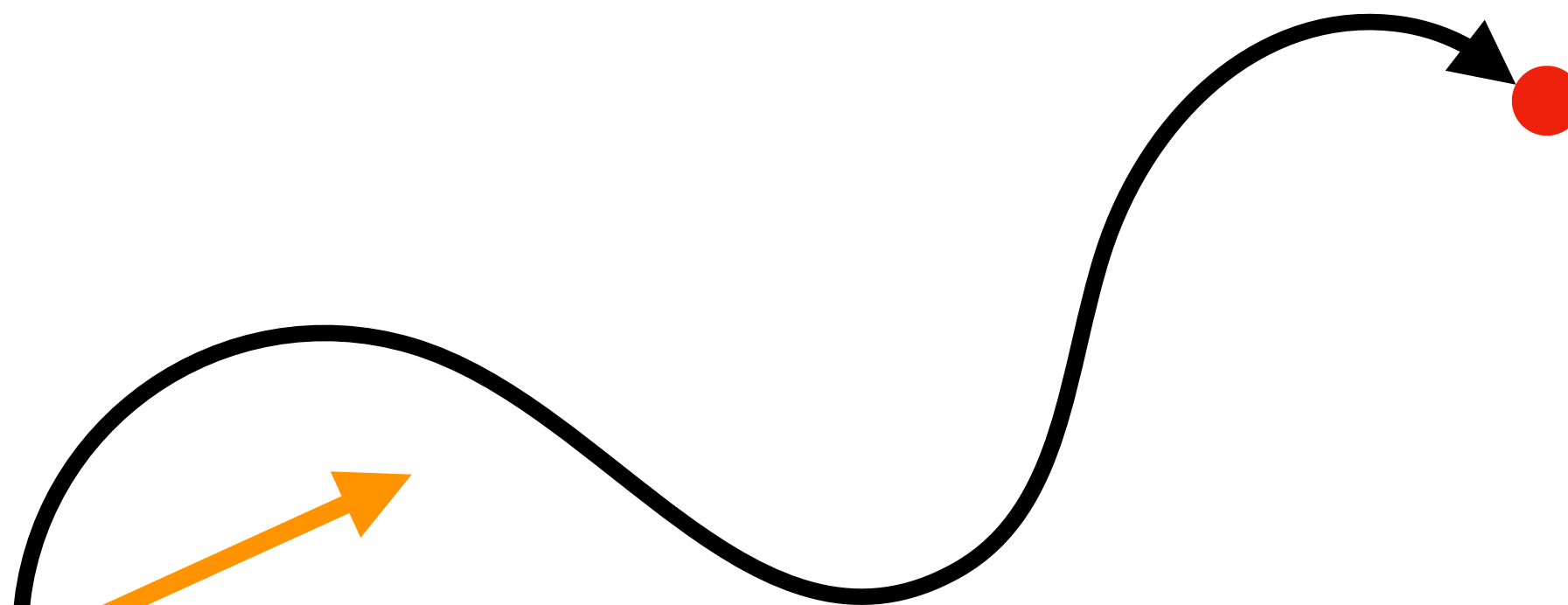


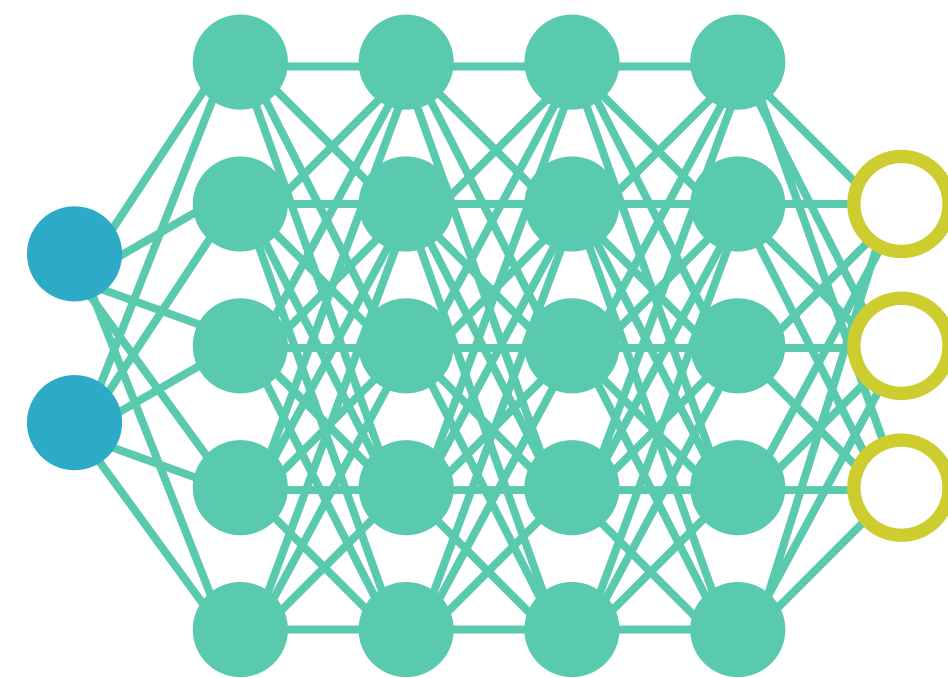


$f_{\theta}$

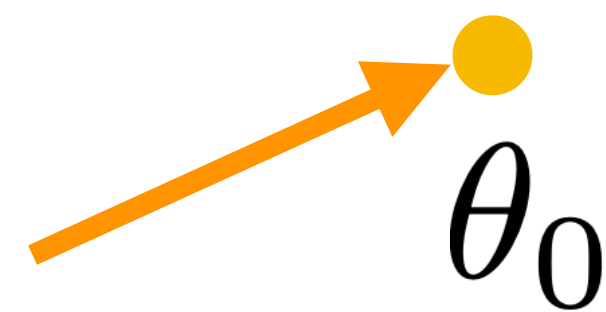


$\theta_0$

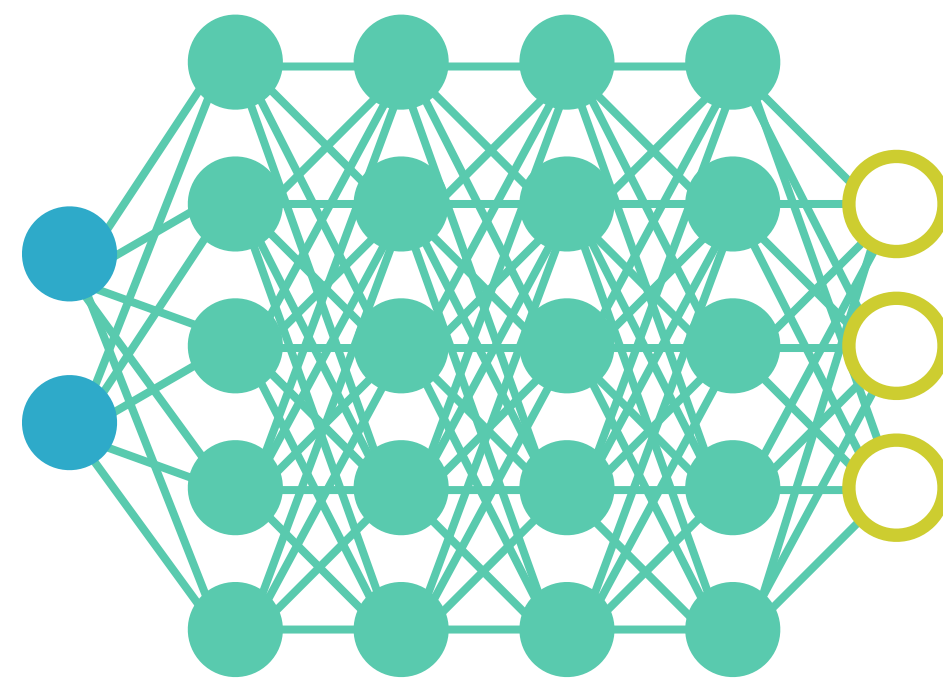




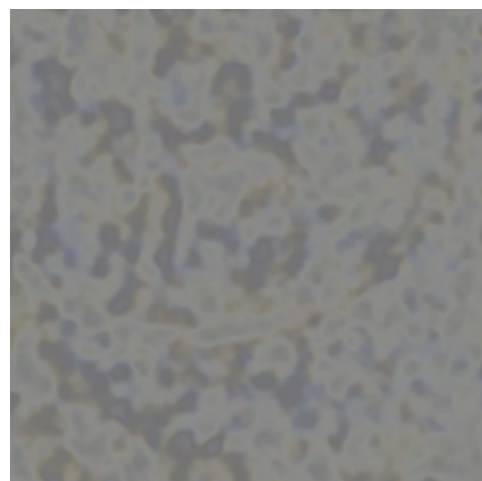
$f_{\theta}$



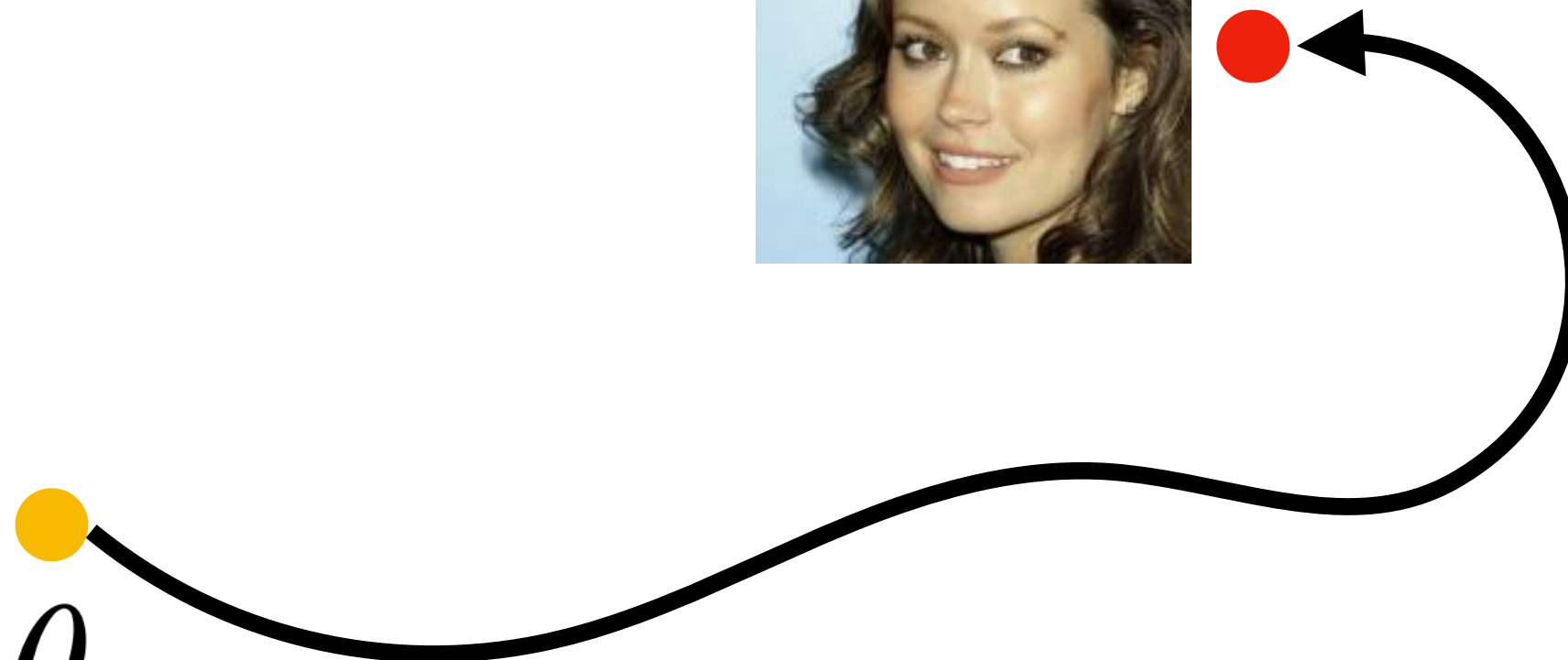


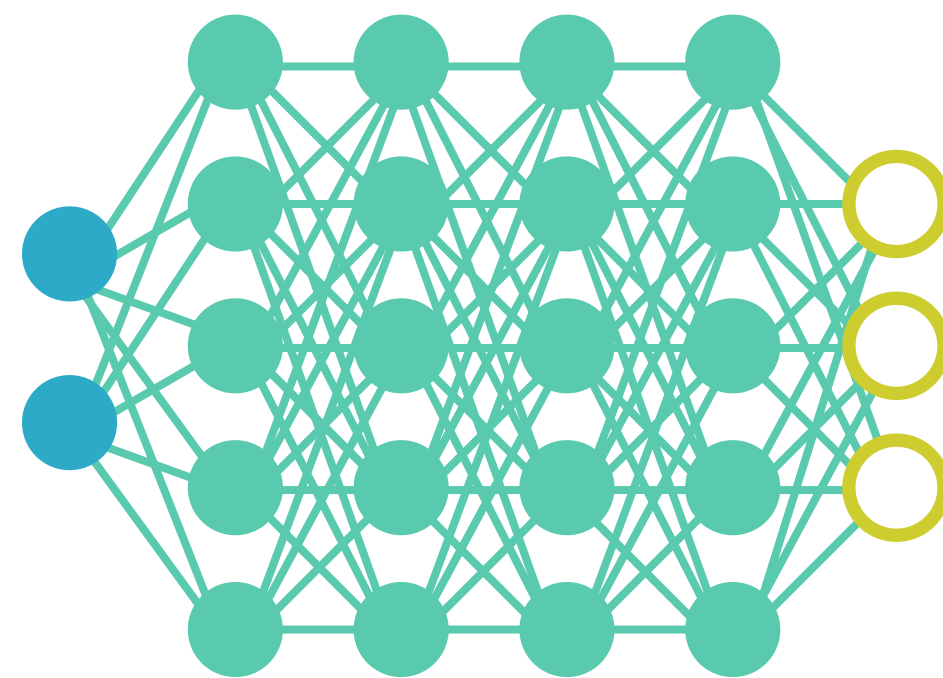


$f_{\theta}$

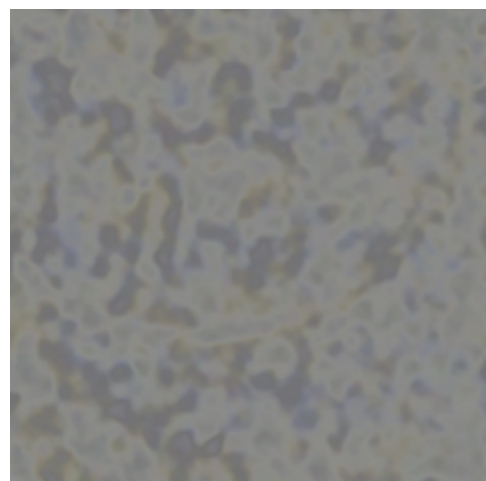


$\theta_0$

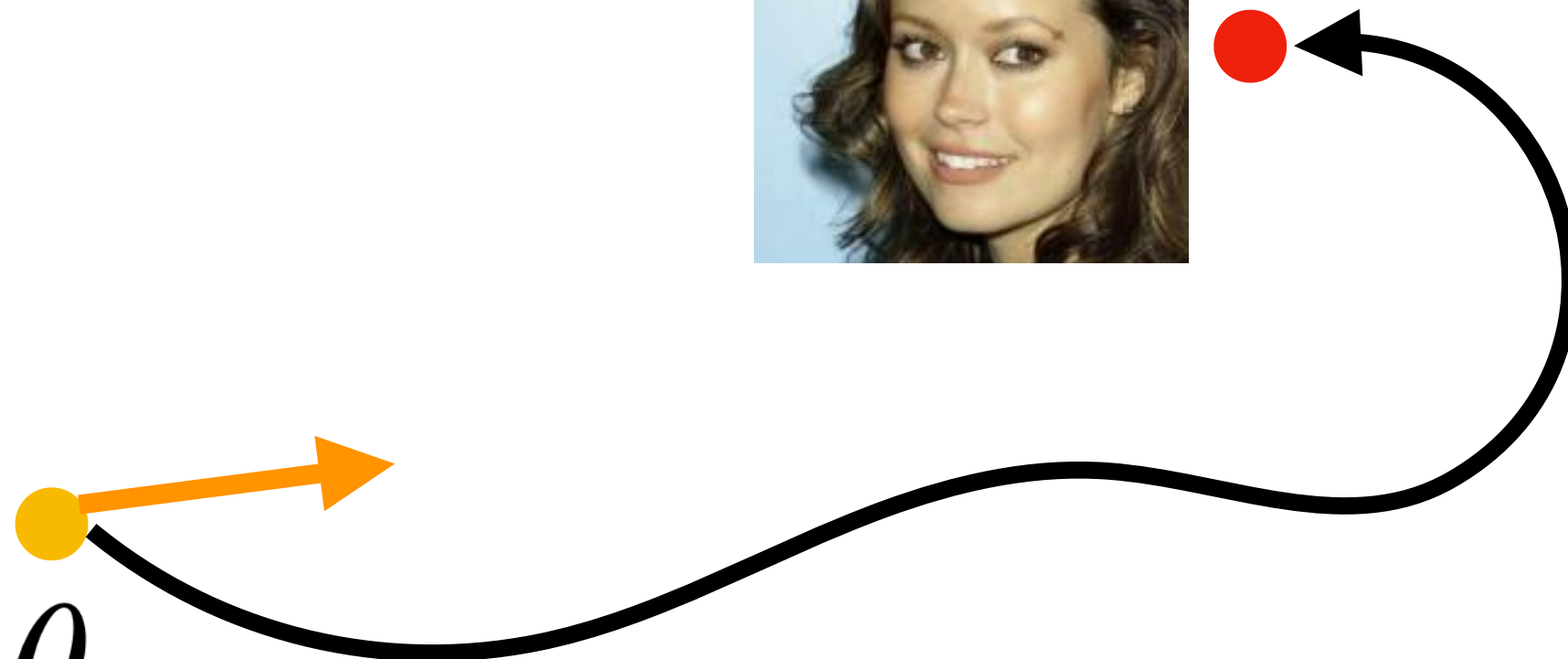


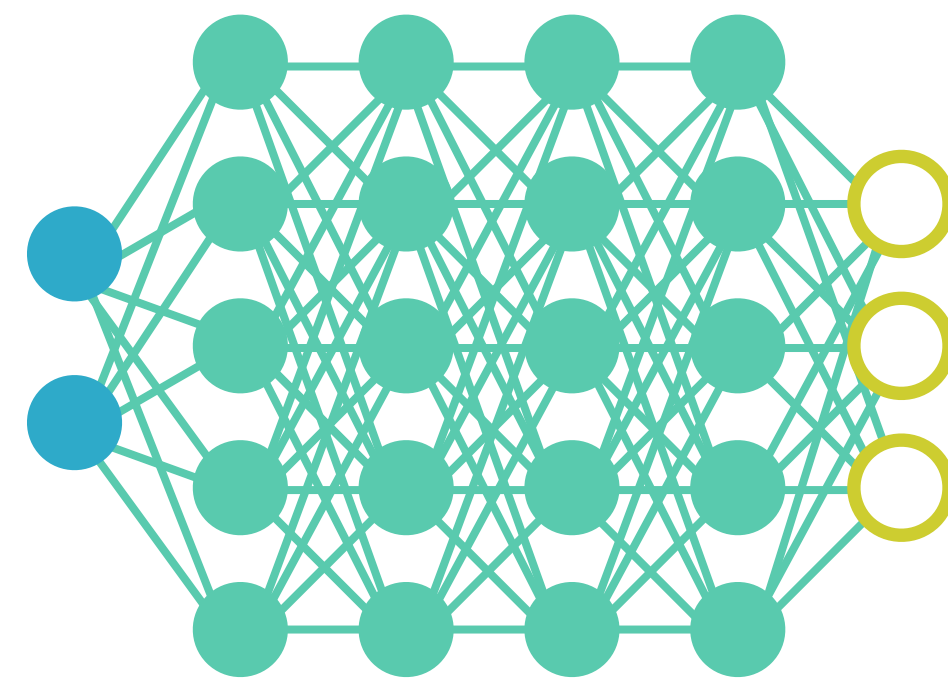


$f_{\theta}$




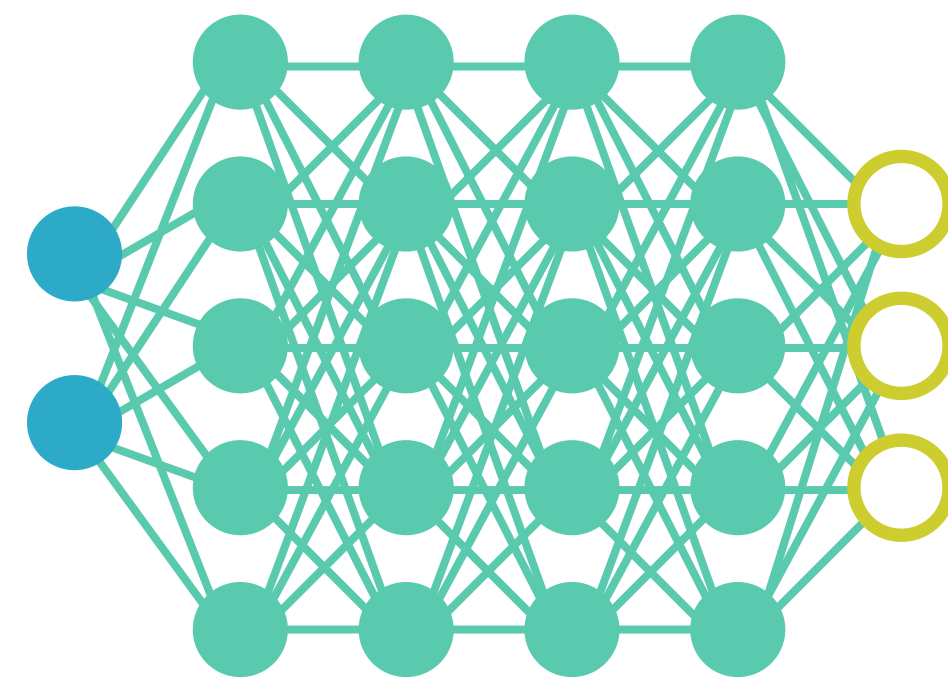
$\theta_0$





$f_{\theta}$

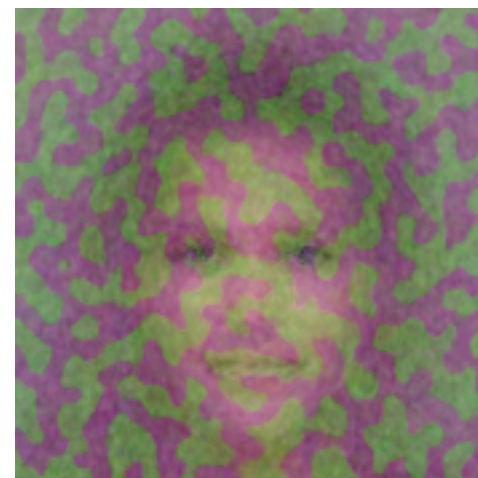
  
 $\theta_0$

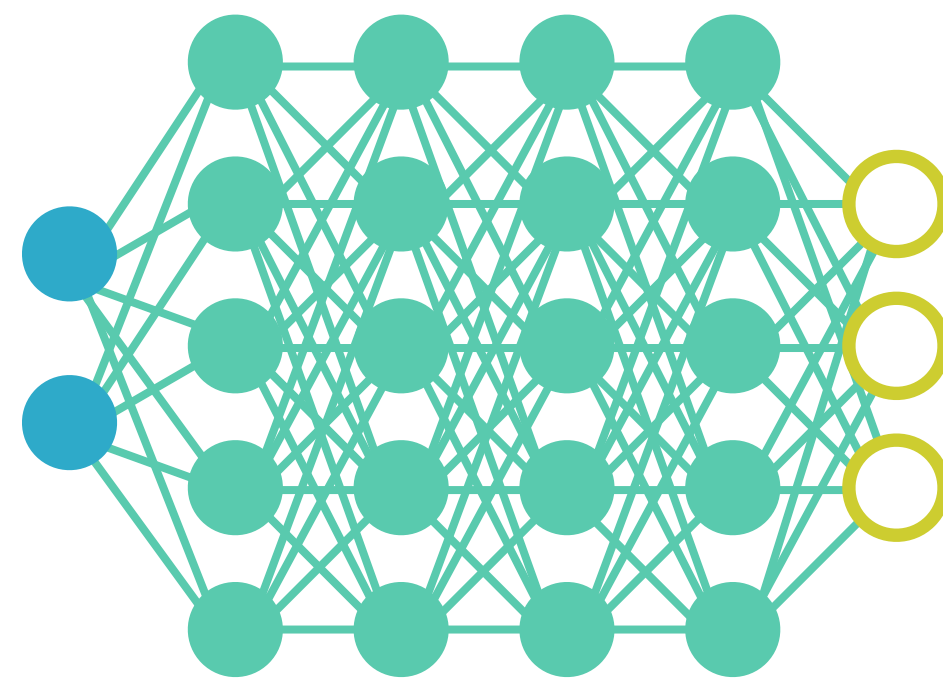


$f_{\theta}$

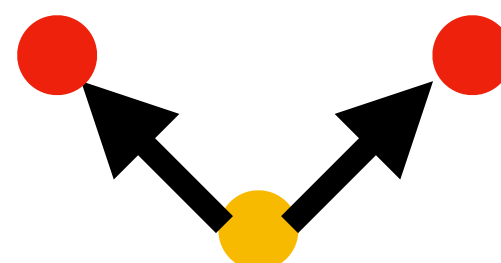


$\theta_0$

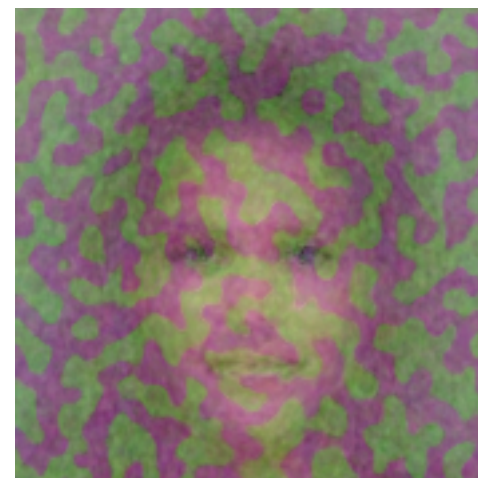




$$f_{\theta}$$



$$\theta_0$$



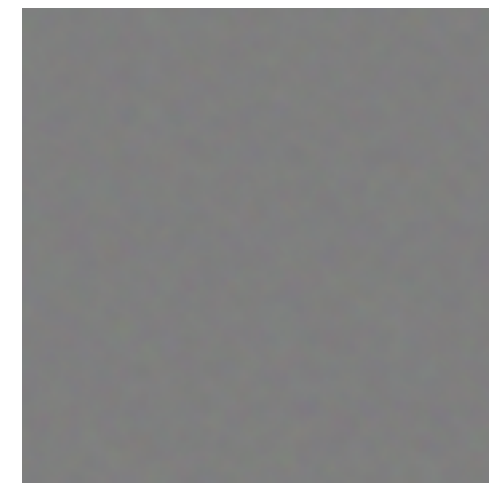


# Image Regression

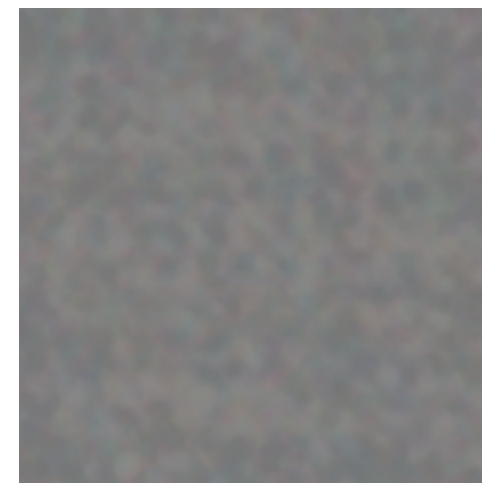


Target

Init.



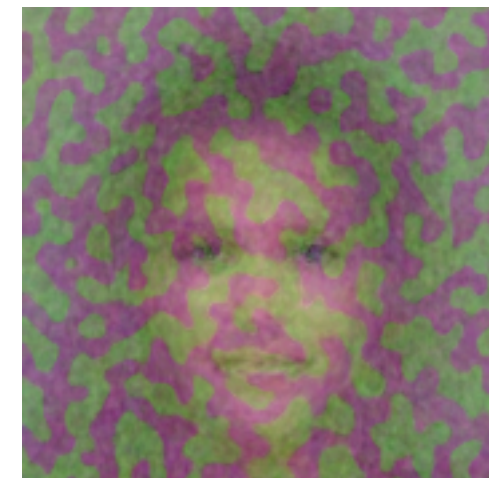
Step 1



Step 2



Standard Initialization



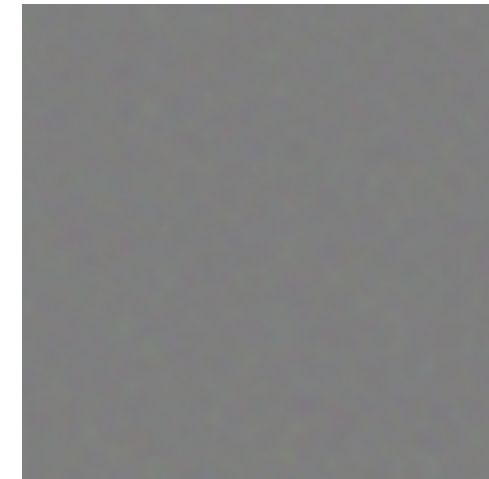
Meta-learned Initialization (MAML)

# Image Regression

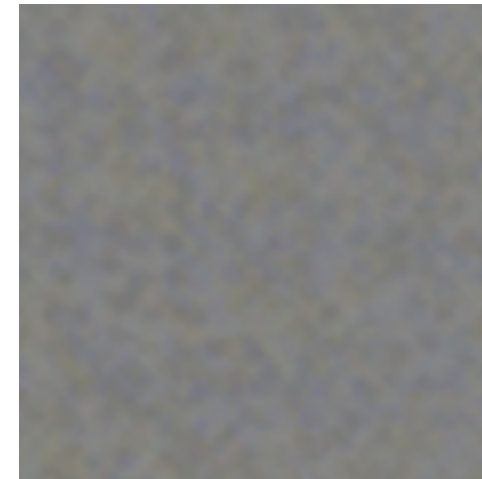


Target

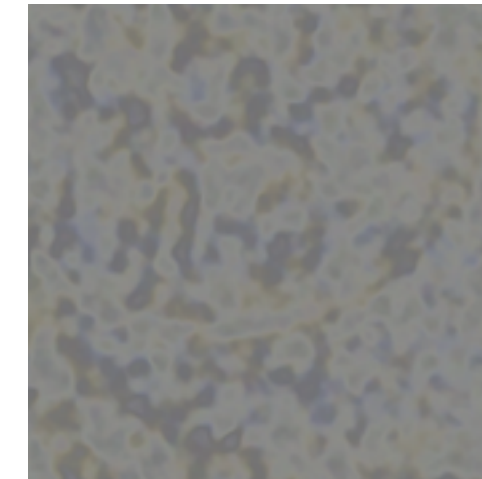
Init.



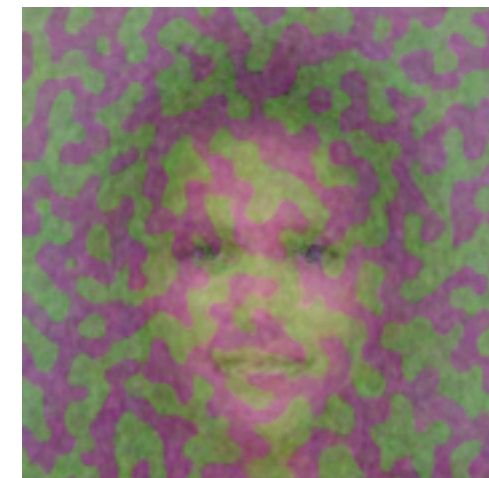
Step 1



Step 2



Standard Initialization



Meta-learned Initialization (MAML)

# Image Regression

		Task			
		CelebA	Imagenette	Text	SDF
Init.	CelebA	<b>30.37</b>	26.44	21.53	36.45
	Imagenette	28.51	<b>27.07</b>	22.63	34.80
	Text	14.65	15.83	<b>27.85</b>	23.14
	SDF	19.80	20.05	17.23	<b>51.73</b>



# Weight Interpolation

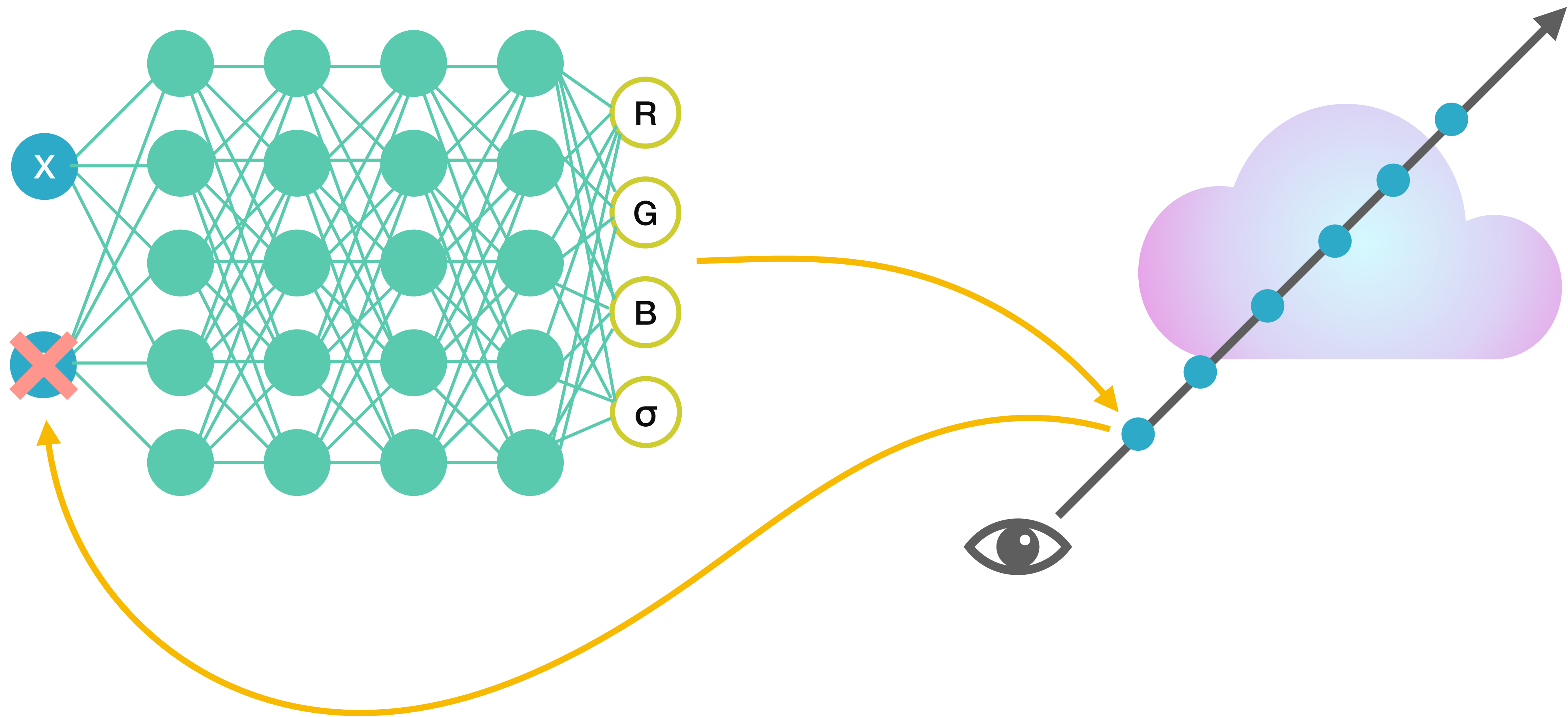


Standard Initialization

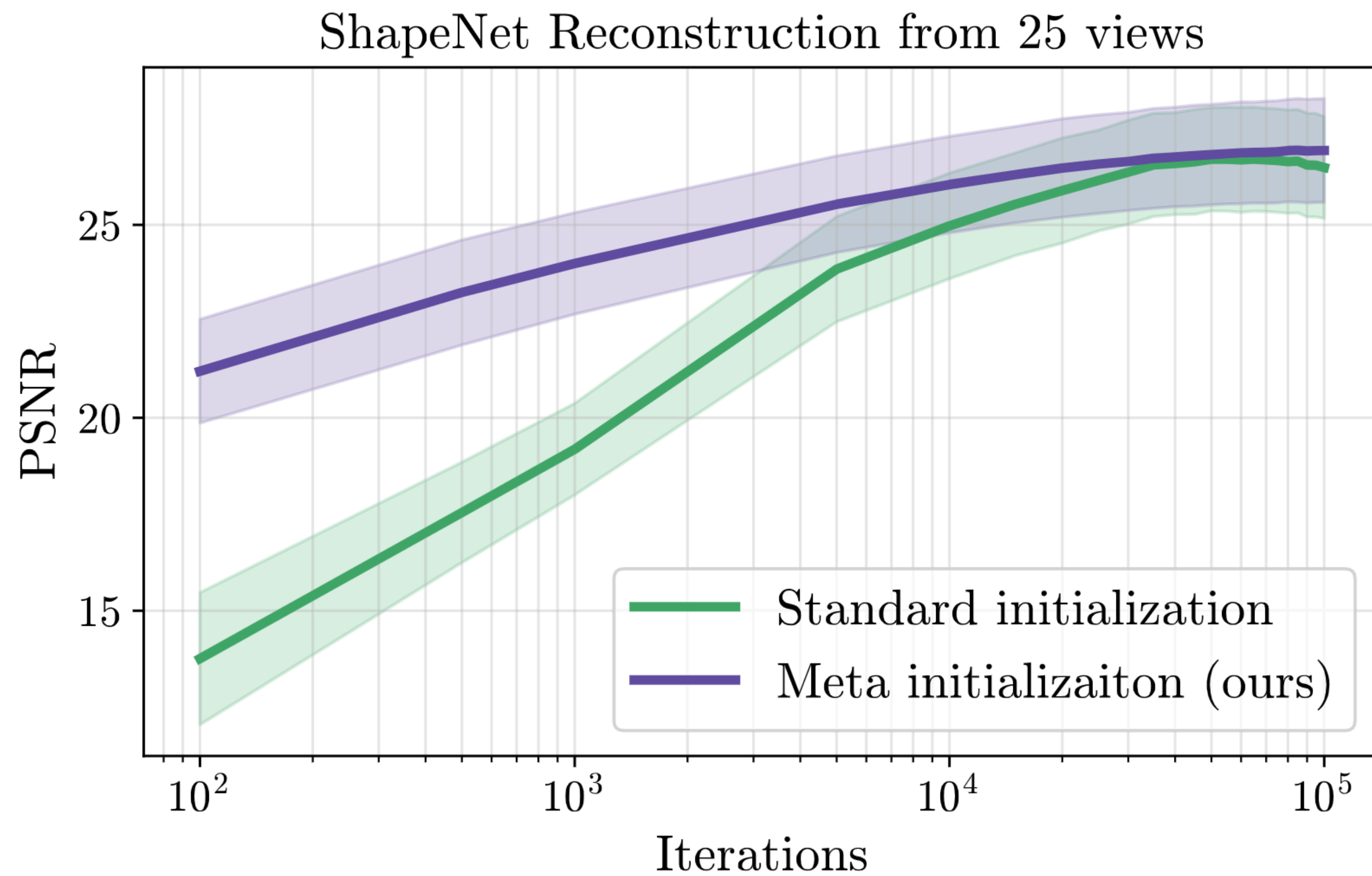


Meta Initialization

# Intro meta-nerf



# NeRF ShapeNet



# NeRF ShapeNet Single Image

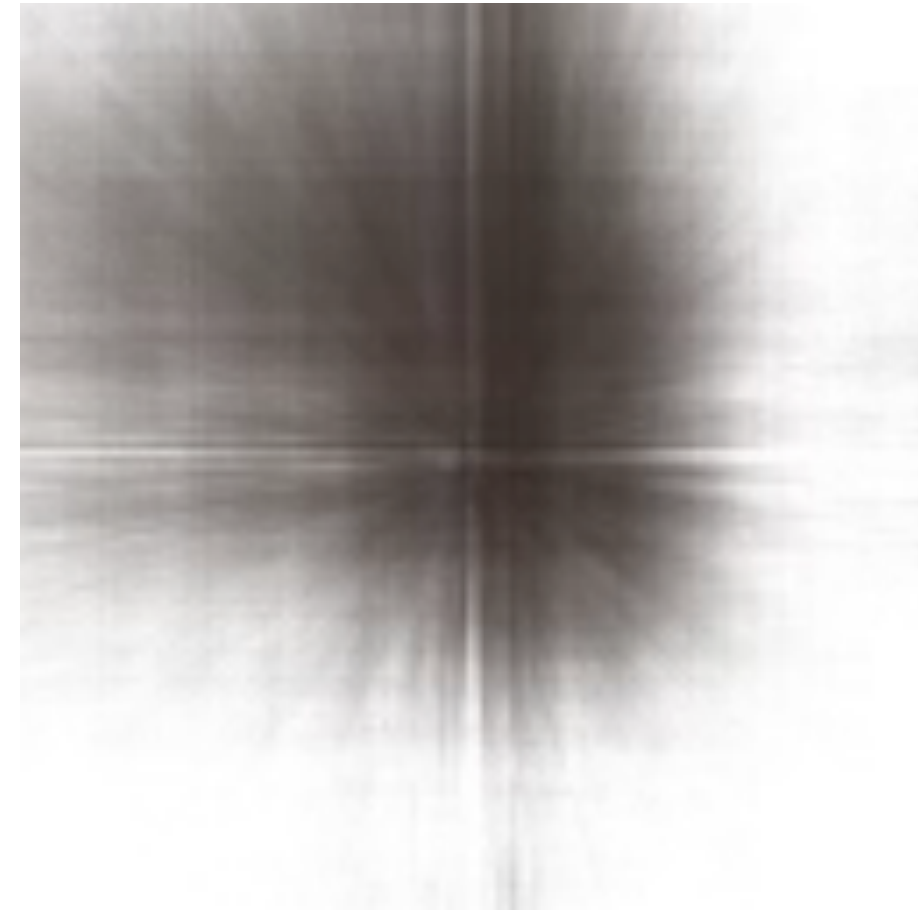


Input

# NeRF ShapeNet Single Image



Input



Standard



MV Meta



SV Meta



# NeRF ShapeNet Single Image



Input

MV Meta

SV Meta

Input

MV Meta

SV Meta

Input

MV Meta

SV Meta





Constrained Capture





Constrained Capture



Phototourism Data





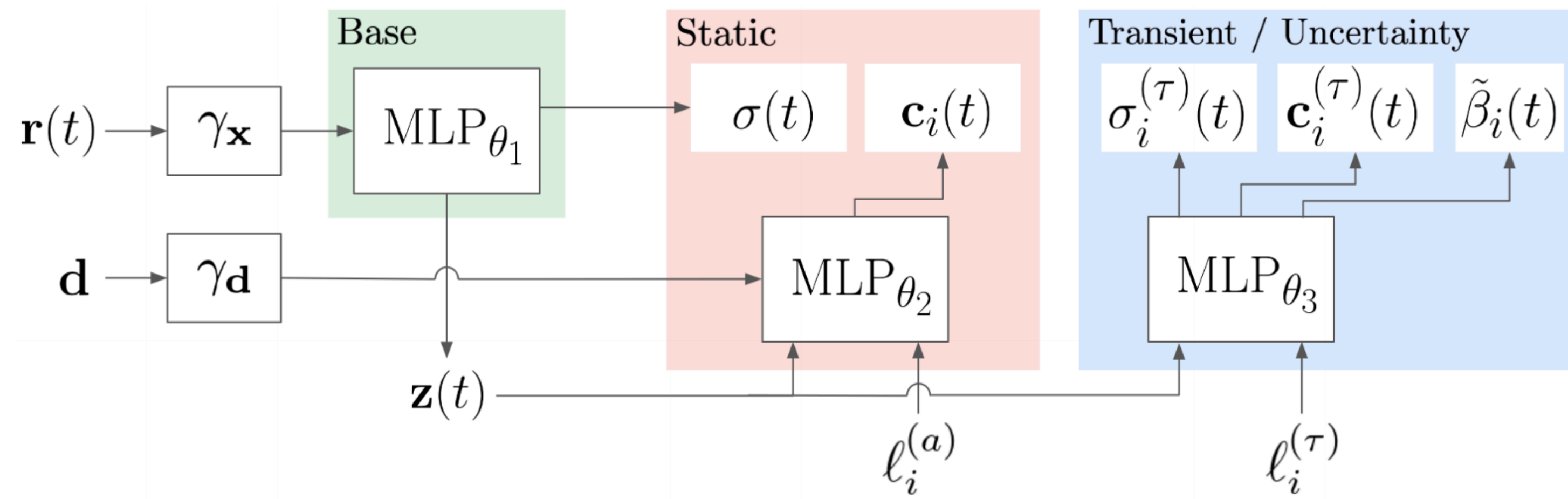
Constrained Capture



Phototourism Data



# NeRF-W : Nerf in the Wild



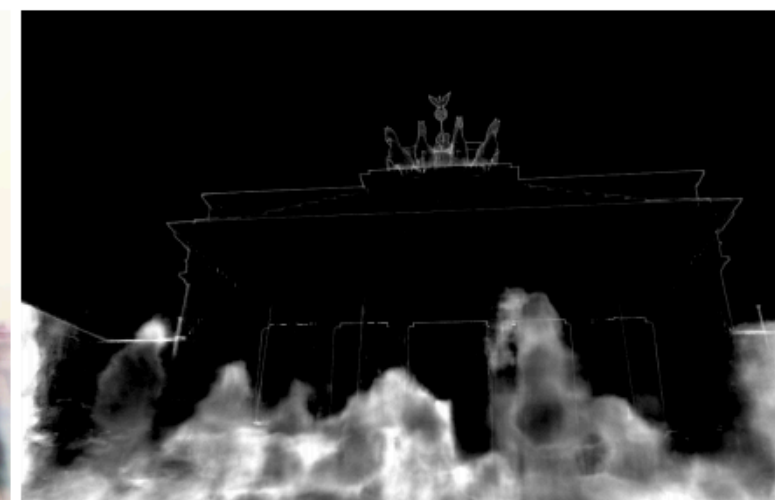
(a) Static



(b) Transient



(c) Combined



(d) Uncertainty



(e) Reference

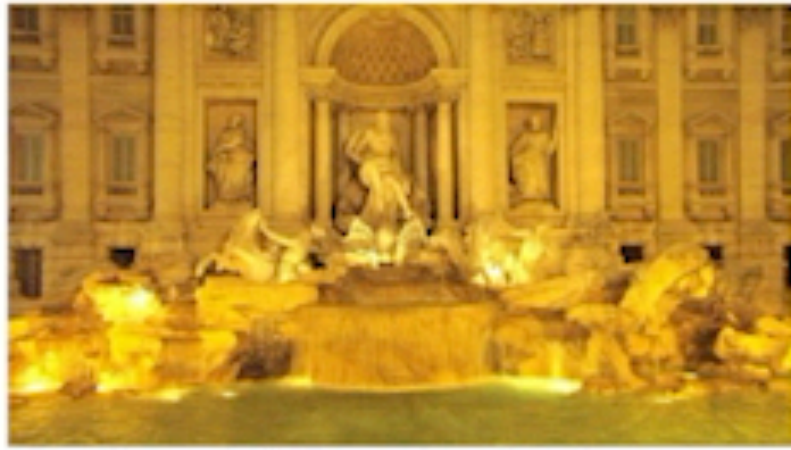
# Phototourism - Meta approach



Target



# Meta-learning weights to reconstruct Phototourism scenes





# Meta-learning weights to reconstruct Phototourism scenes





# Phototourism - Meta approach





# Phototourism - Meta approach



# pixelNeRF: Neural Radiance Fields from One or Few Images

Alex Yu

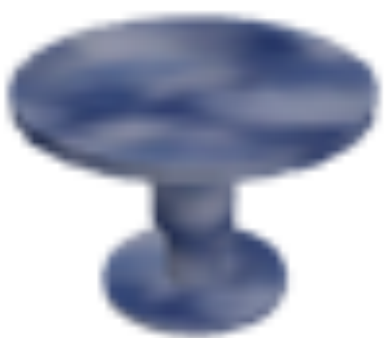
Vickie Ye

Matthew Tancik

Angjoo Kanazawa



Input



pixelNeRF



Input



pixelNeRF



2 Input Views



pixelNeRF





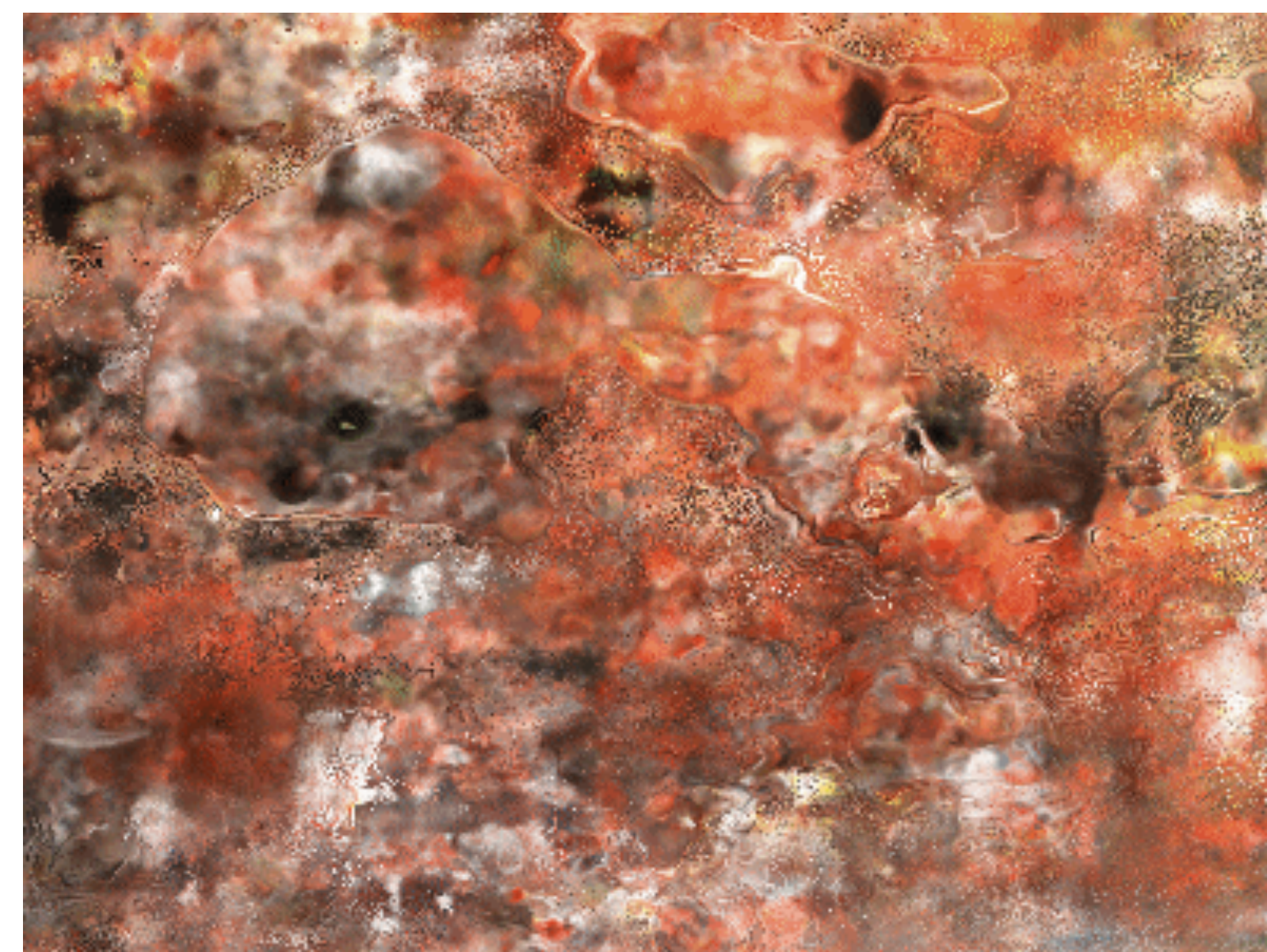


3 Input Views

→  
pixelNeRF

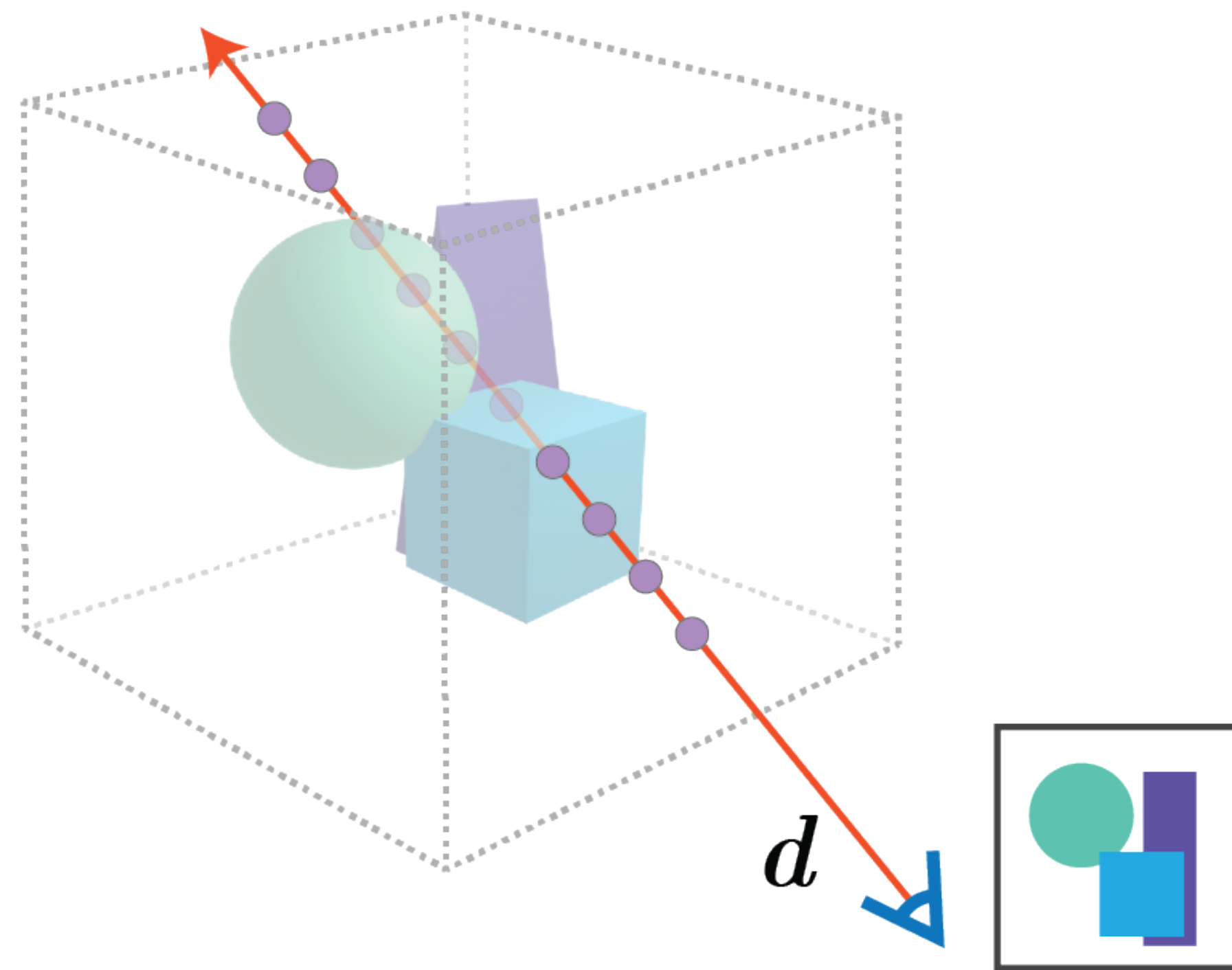


→  
NeRF





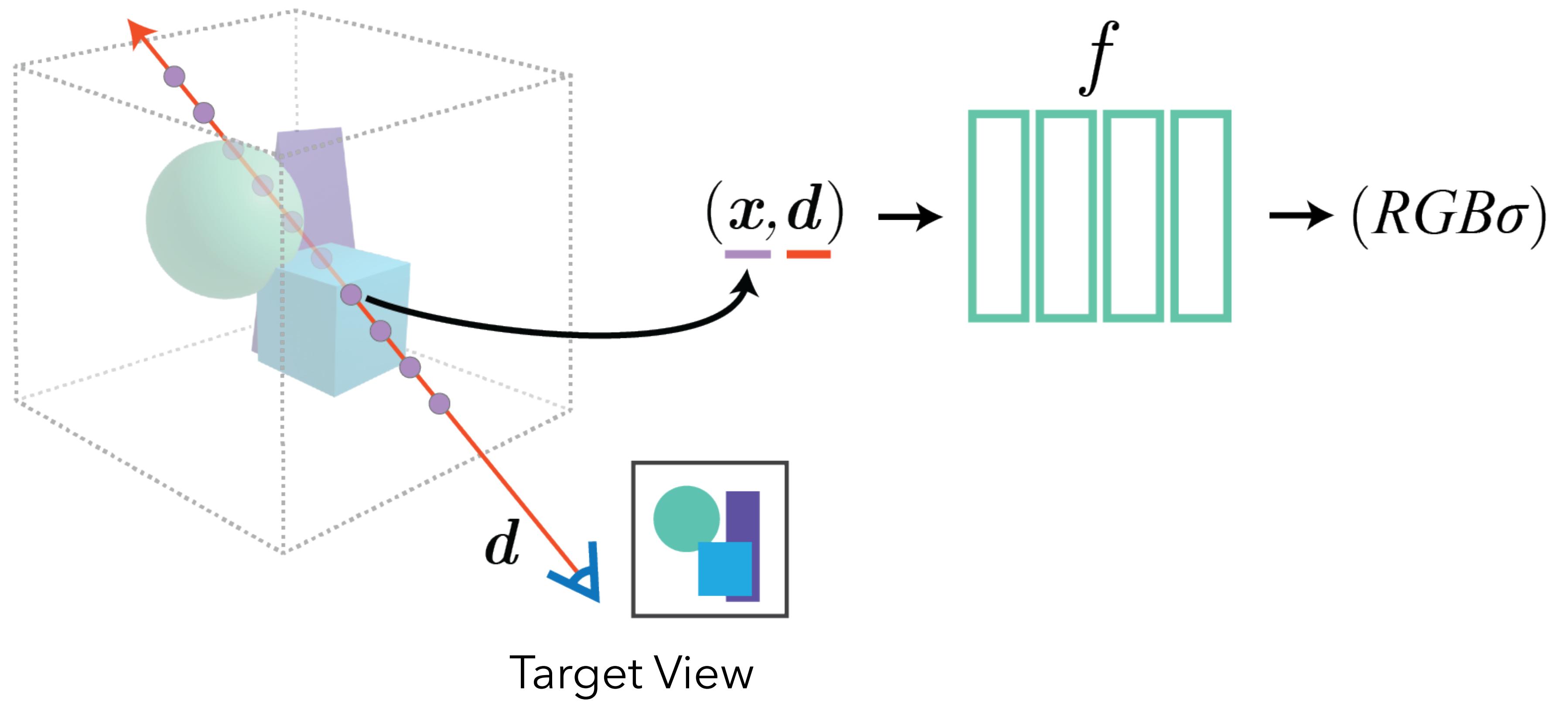
# Method



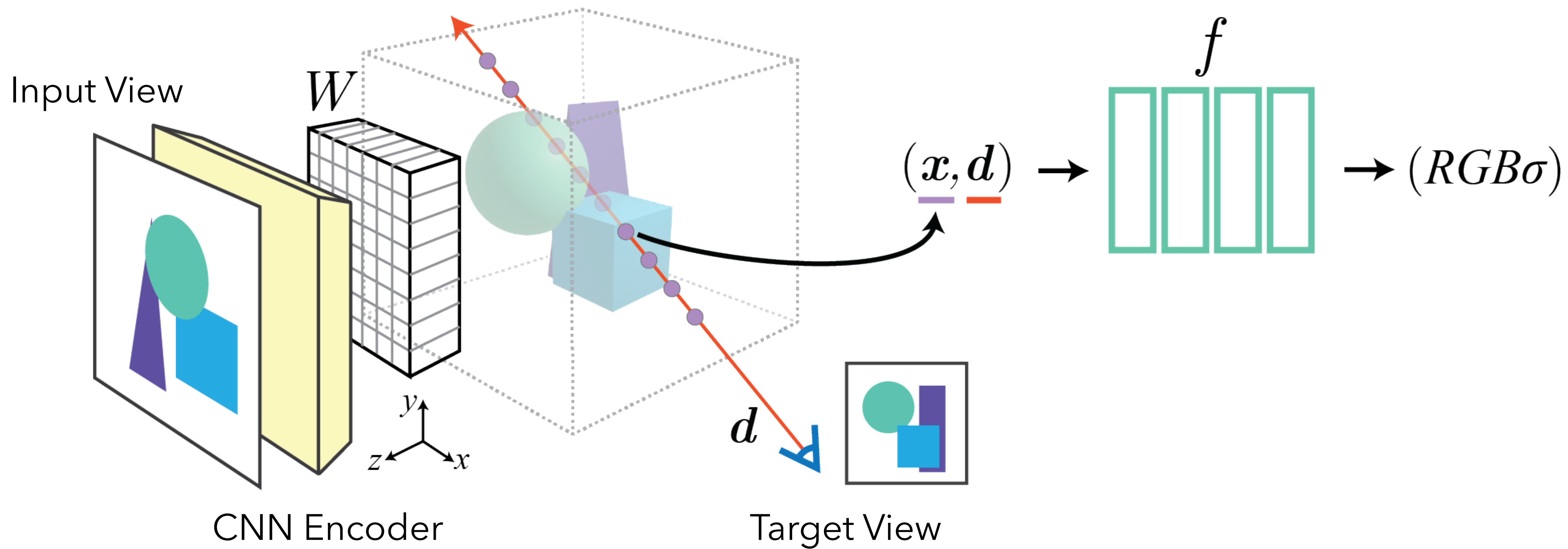
Target View



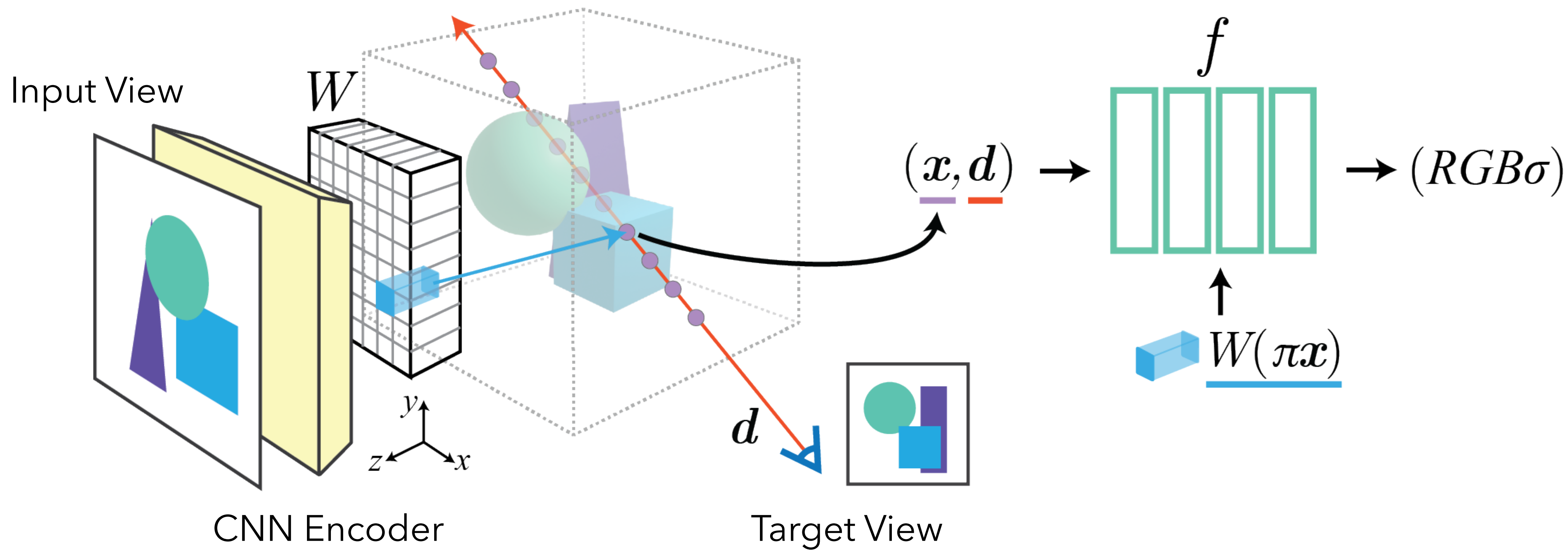
# Method



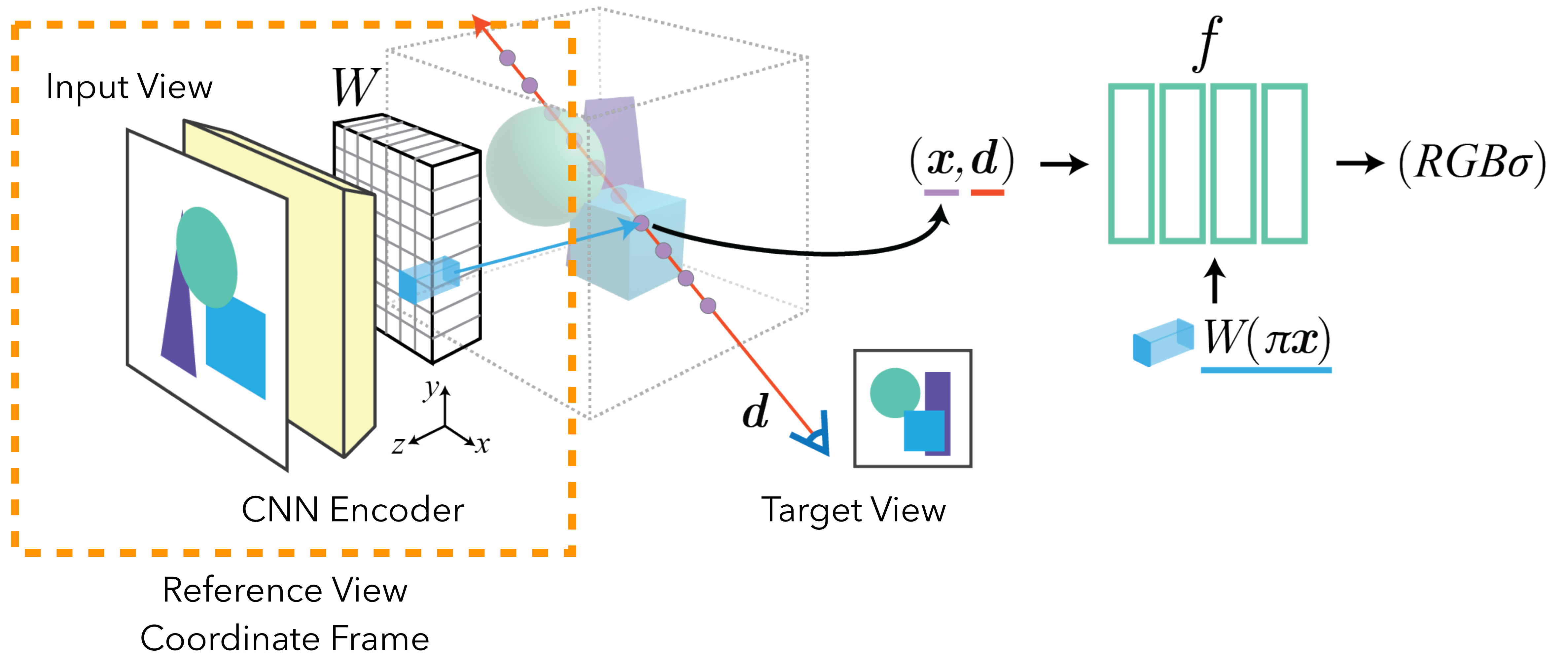
# Method



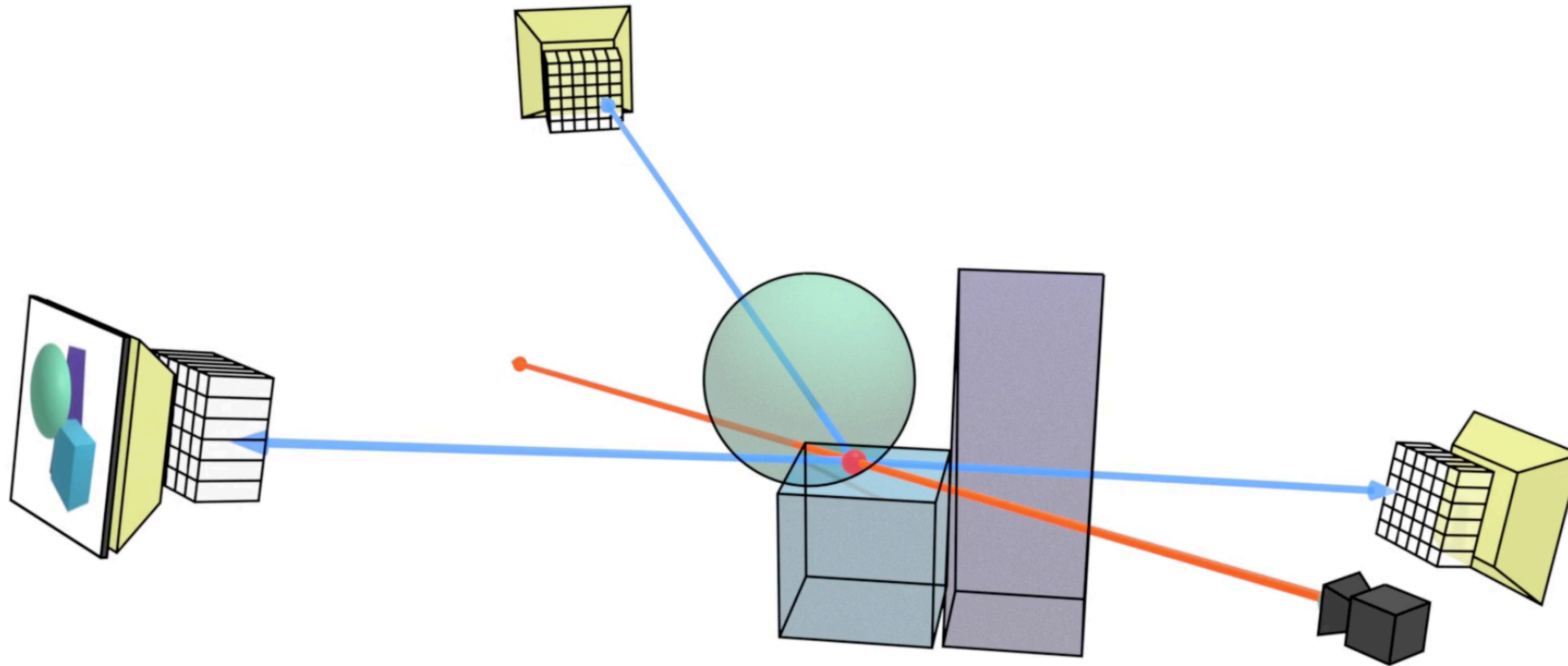
# Method



# Method

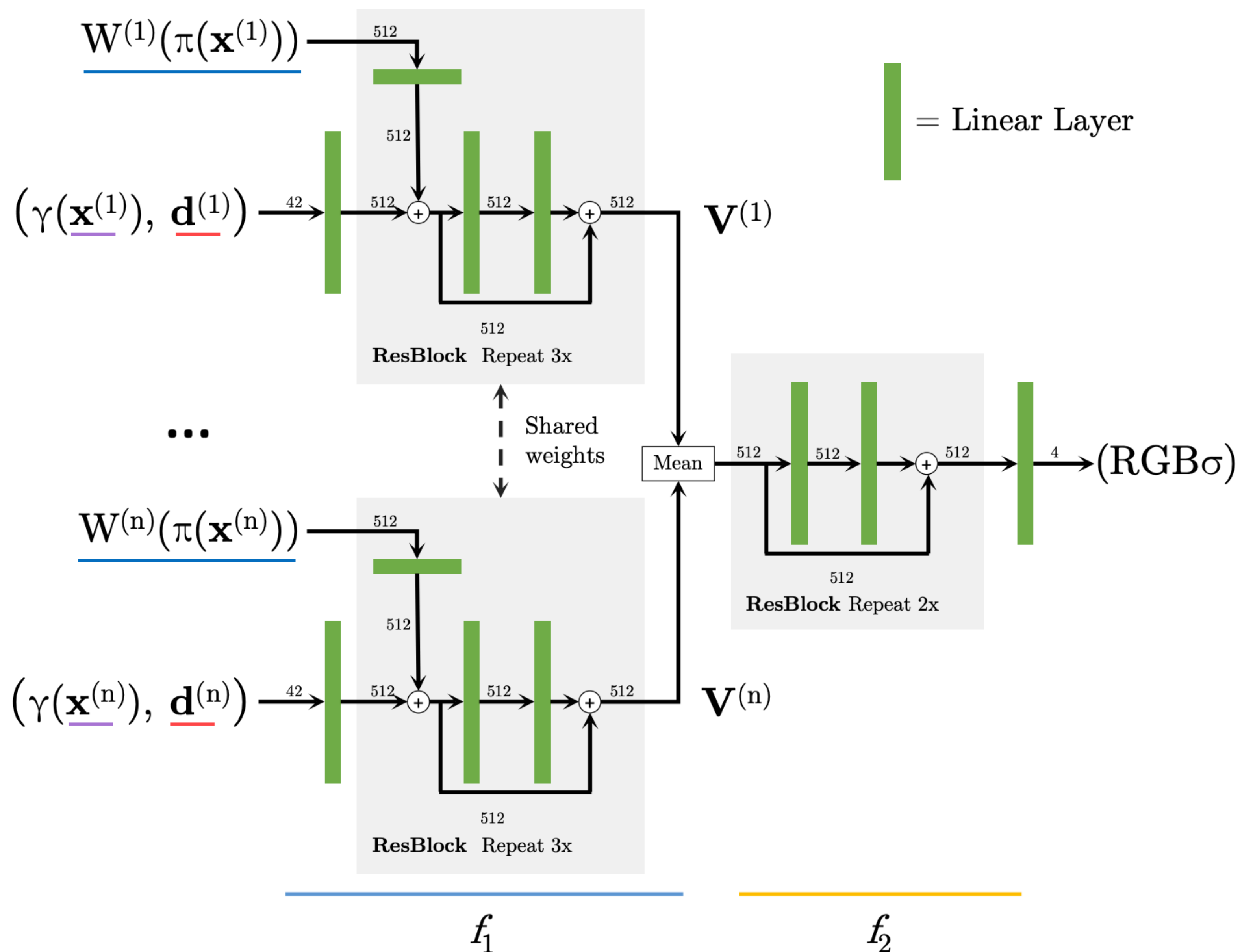


# Multiple Views



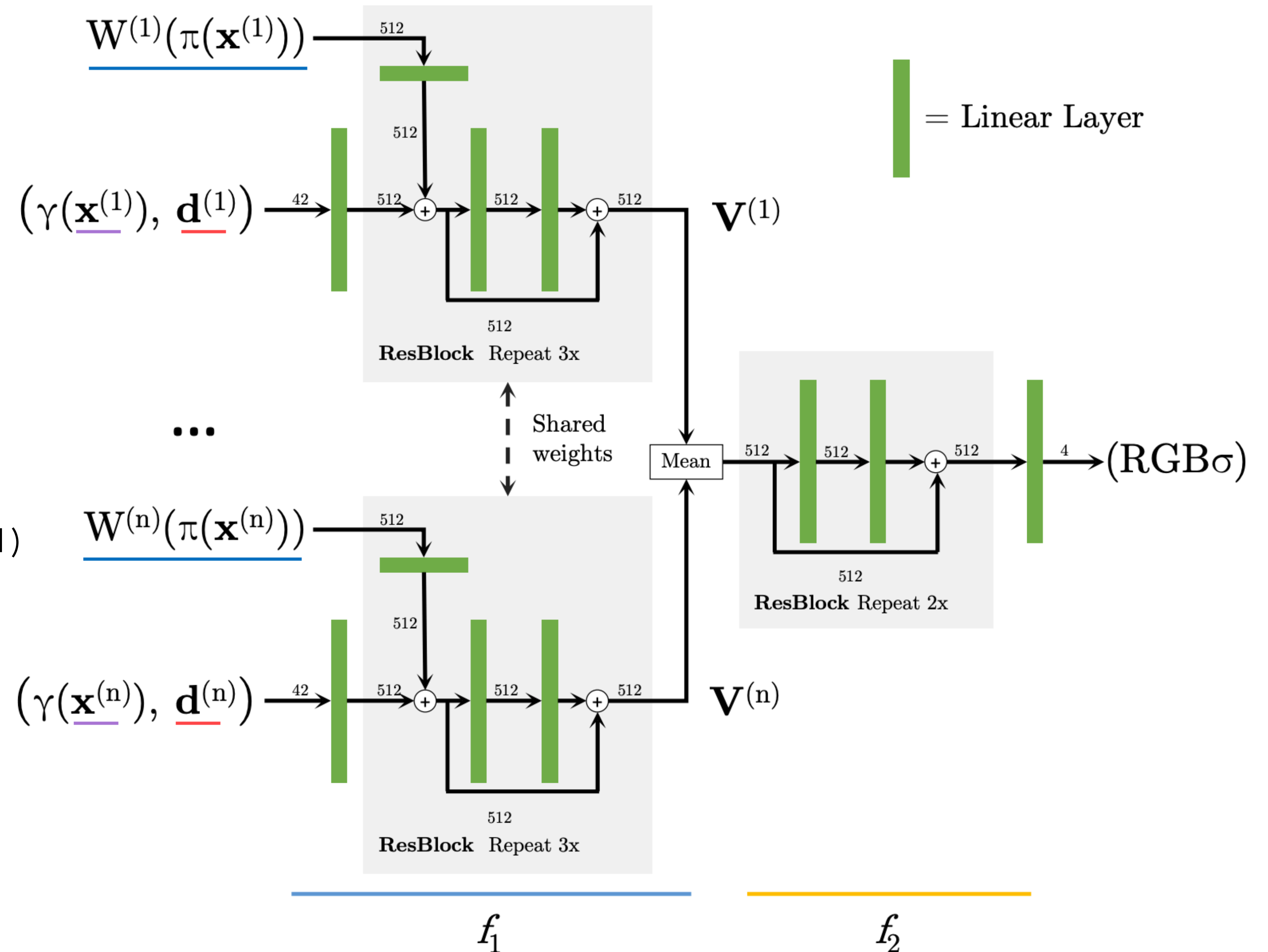
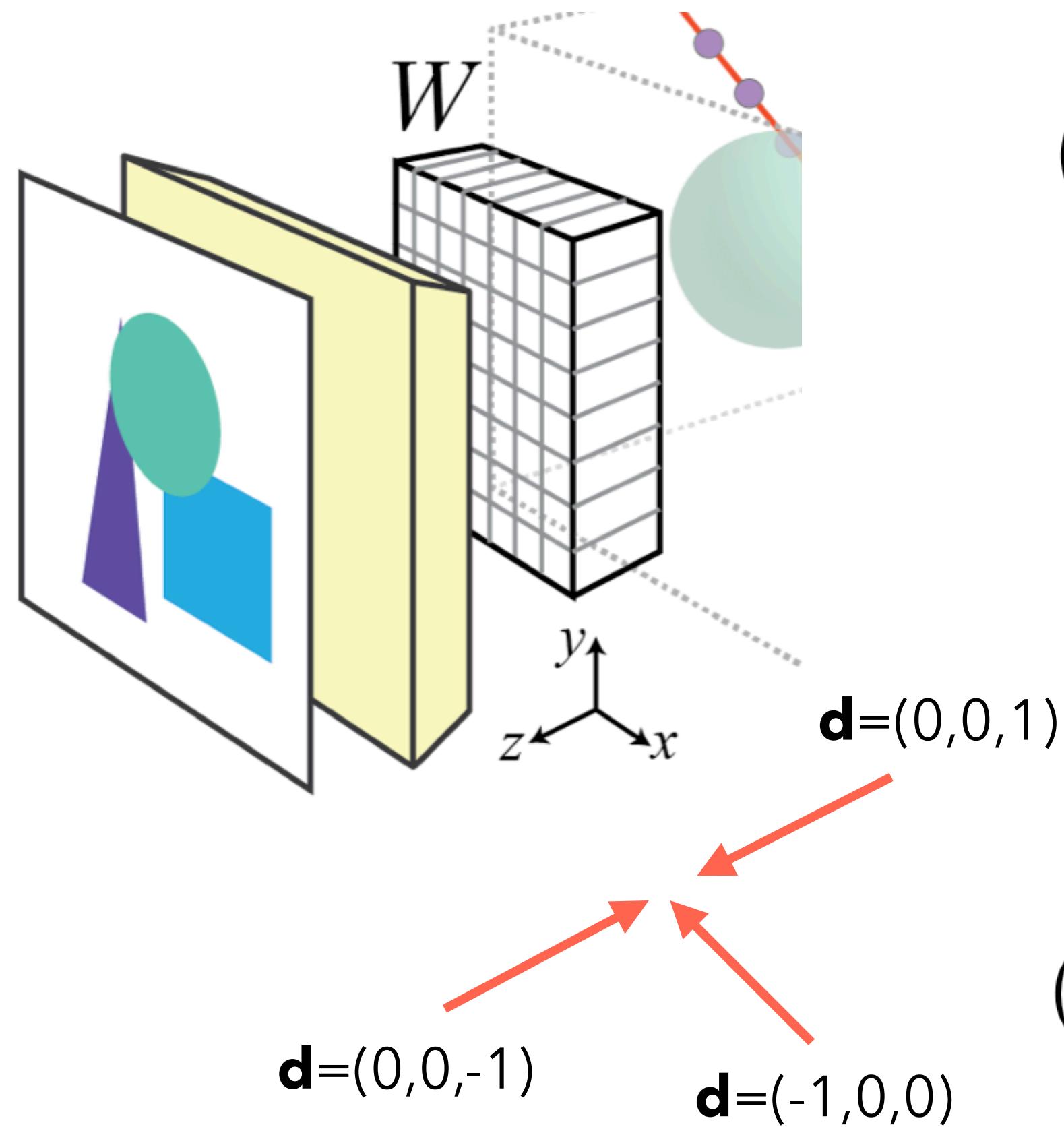


# Multiple Views





# Multiple Views



# Experiments: Overview

**ShapeNet**

Category  
Agnostic



Unseen  
Category



Multi-object  
Scenes



Sim2Real

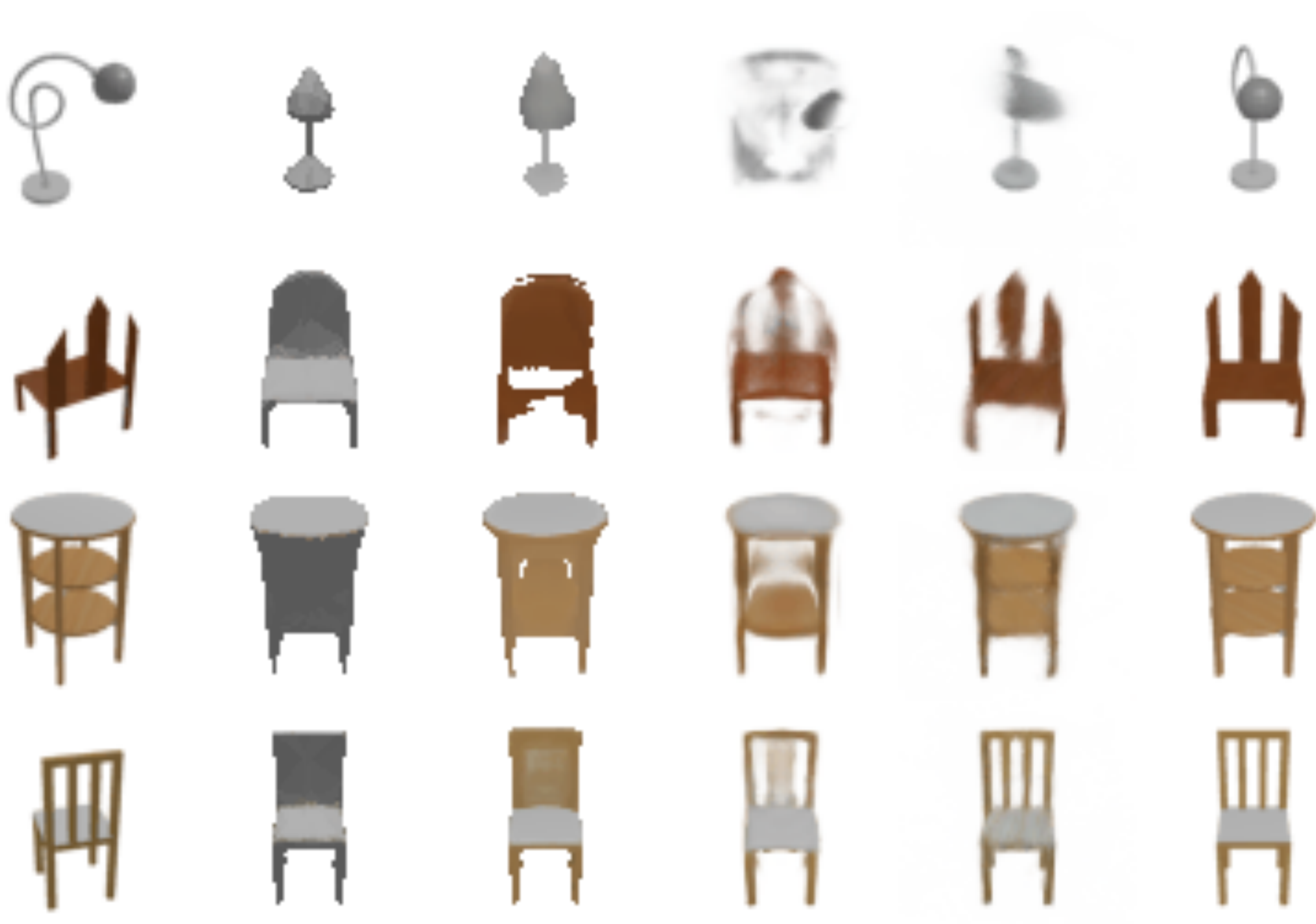


**DTU**

Real image



# ShapeNet Category-agnostic



Input

SoftRas

DVR

SRN

pixelNeRF

GT

(canonical space) (canonical space) (canonical space)

**(view space)**



# ShapeNet Category-agnostic



Input

SoftRas

DVR

SRN

pixelNeRF

GT

(canonical space) (canonical space) (canonical space)

**(view space)**

# Generalizing to Novel Categories



**Training Categories**



Input

DVR

SRN

pixelNeRF

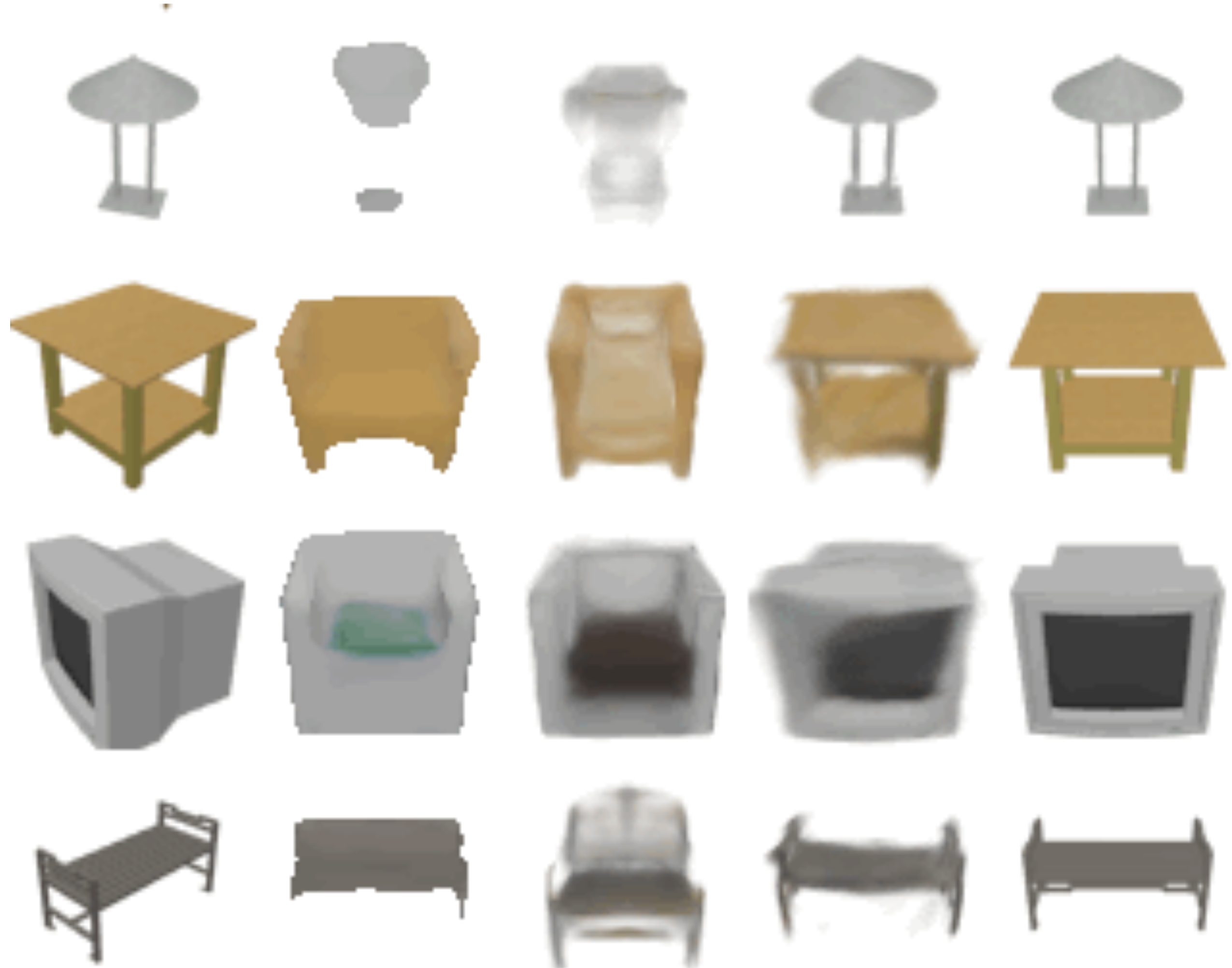
GT

**Unseen Categories**

# Generalizing to Novel Categories



**Training Categories**



Input

DVR

SRN

pixelNeRF

GT

**Unseen Categories**



# Two-object Scenes

1 Input View      SRN      pixelNeRF  
(canonical space)      (**view space**)



2 Input Views      SRN      pixelNeRF  
(canonical space)      (**view space**)



# Two-object Scenes

1 Input View      SRN      pixelNeRF  
(canonical space)      (**view space**)



2 Input Views      SRN      pixelNeRF  
(canonical space)      (**view space**)





# Real Cars



Input

pixelNeRF

Input

pixelNeRF

Input

pixelNeRF

Input

pixelNeRF



- Scene prior from 88 training scenes
- Test with 3 input views of unseen scene

**DTU**

Real image





# DTU Results

1 View



3 Views



6 Views



9 Views

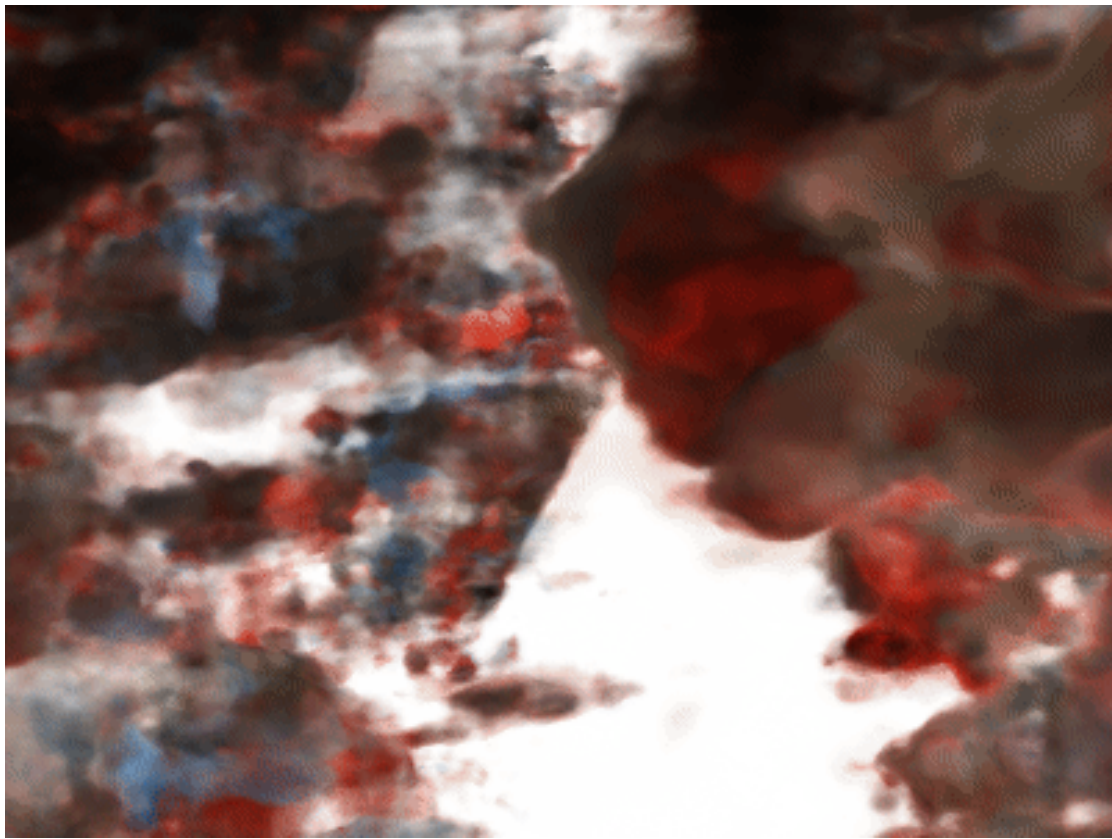
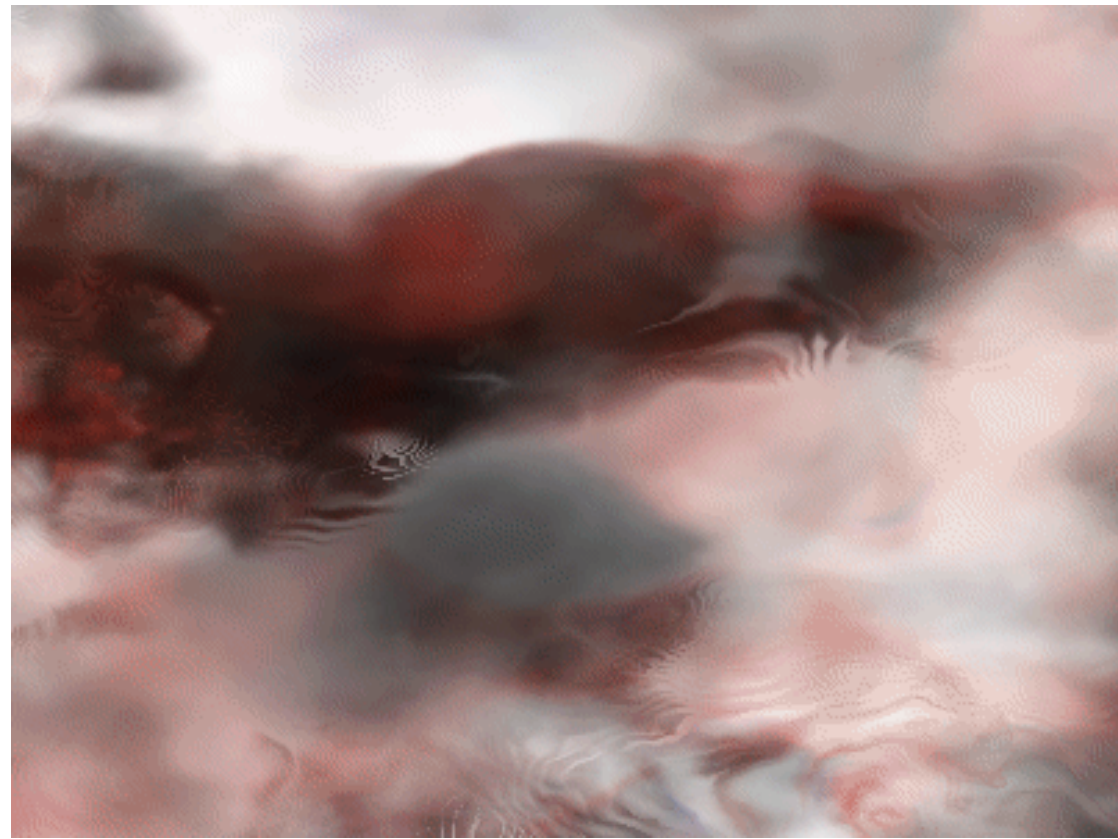


Input

pixelNeRF  
(30 s)



NeRF  
(14 hr)





# DTU Results

3 Input Views



pixelNeRF





# DTU Results

3 Input Views



pixelNeRF





# Learn Initializations for Optimizing Coordinate-Based Neural Representations

**[tancik.com/learnit](https://tancik.com/learnit)**

## PixelNeRF Neural Radiance Fields from One of Few Images

**[alexyu.net/pixelnerf/](https://alexyu.net/pixelnerf/)**



Ben Mildenhall



Alex Yu



Vickie Ye



Terrance Wang



Divi Schmidt



Pratul Srinivasan



Jonathan T. Barron



Angjoo Kanazawa



Ren Ng