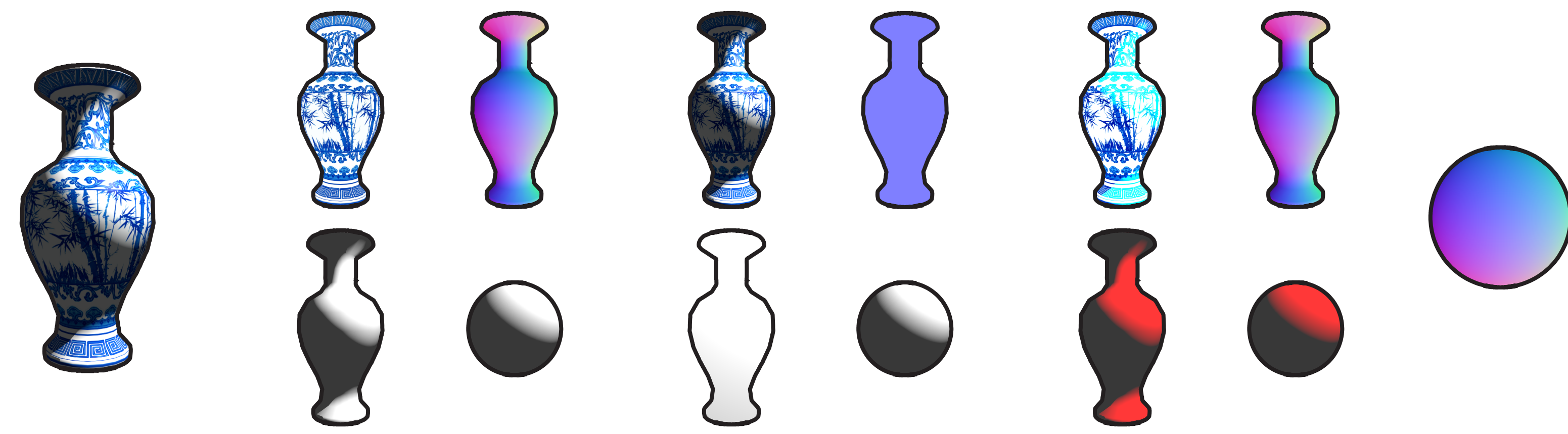
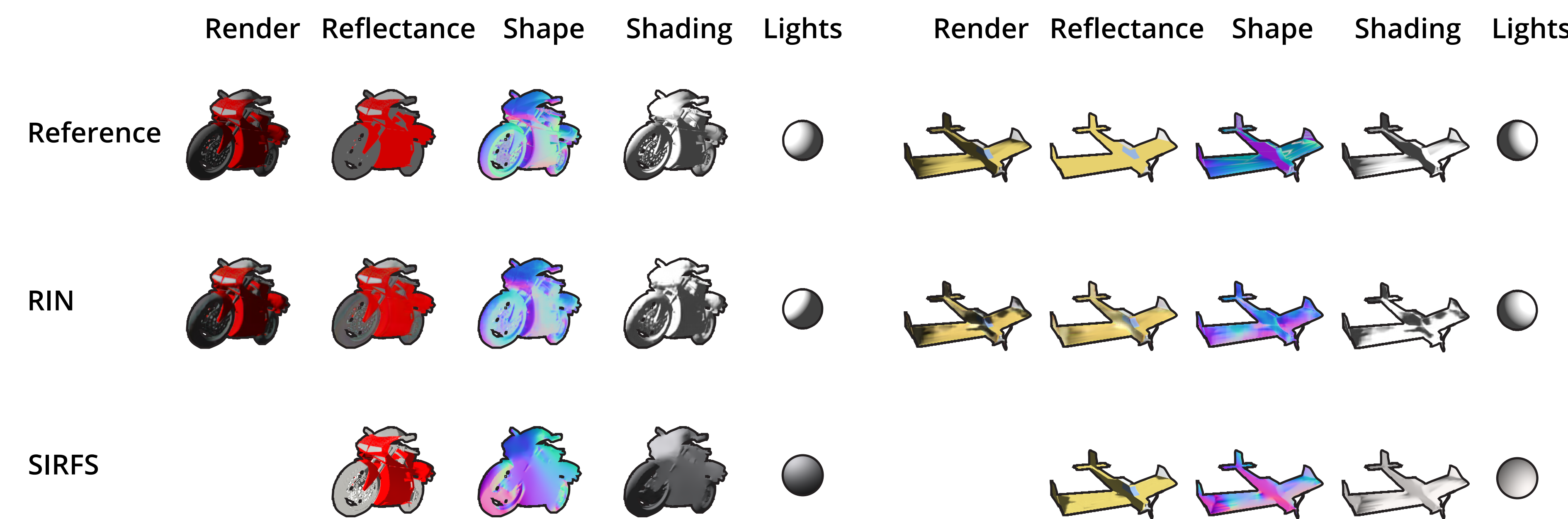


Motivation

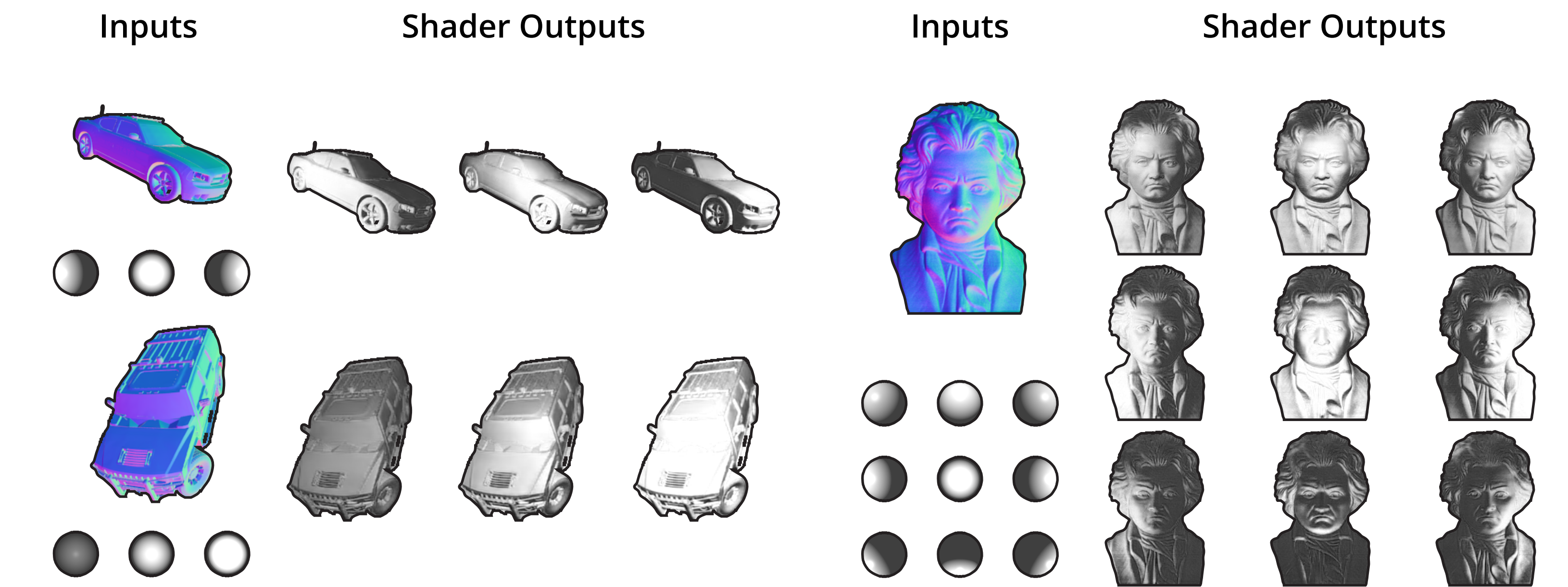


- Predicting the **reflectance**, **shape**, **shading**, and **lighting** of an image is a highly underconstrained problem
- Prior work assumes access to either hand-crafted priors or ground truth intrinsic images for all training examples
- Our work uses **unlabeled images** to update intrinsic image representations

Predictions

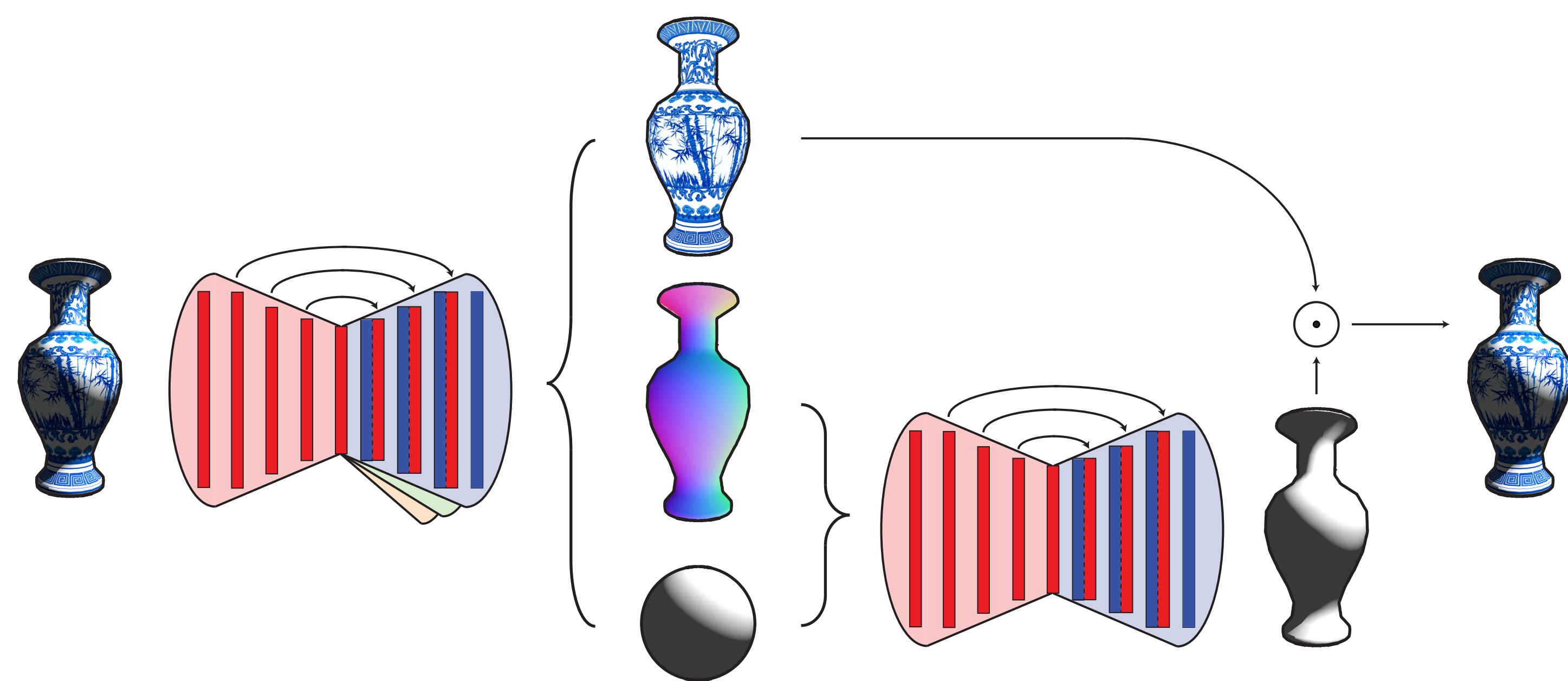


	Motorbike (Train)			Airplane (Transfer)		
	Reflectance	Shape	Lights	Reflectance	Shape	Lights
RIN	0.0021	0.0044	0.1398	0.0042	0.0119	0.4873
SIRFS	0.0059	0.0094	—	0.0054	0.0080	—



- Poor intrinsic image predictions are reflected in reconstruction quality, providing an **additional error signal**
- Learned shading engine** produces accurate shading images of real objects after training only on synthetic cars

Rendered Intrinsic Network



- Simultaneously train an intrinsic image **decomposition** function with a **recombination** function
- RIN functions as a **structured autoencoder** with useful intermediate representations
- Recombination function is realized as a **learned shading engine**, with final rendering given by

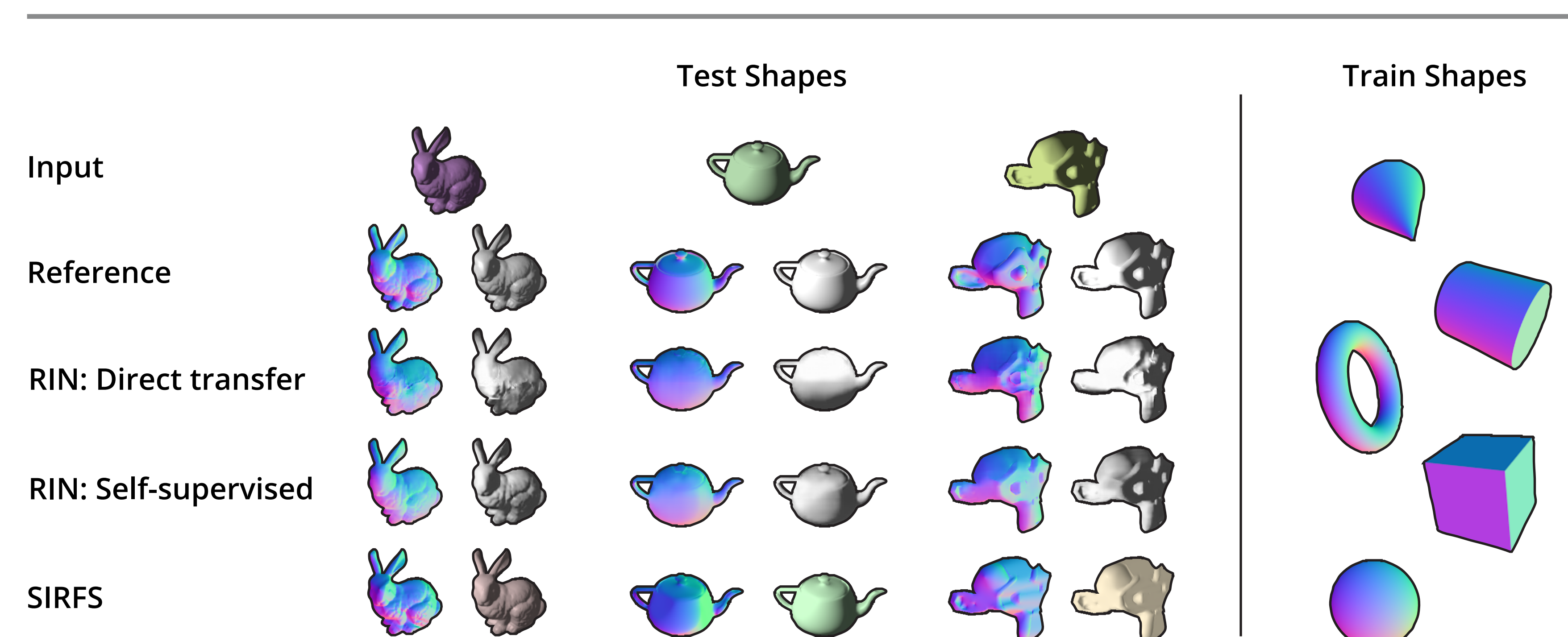
$$\text{image } I = \text{reflectance } R \cdot \text{shading } S$$

- Decomposition function is parameterized as three separate **convolutional decoders**

Generalization

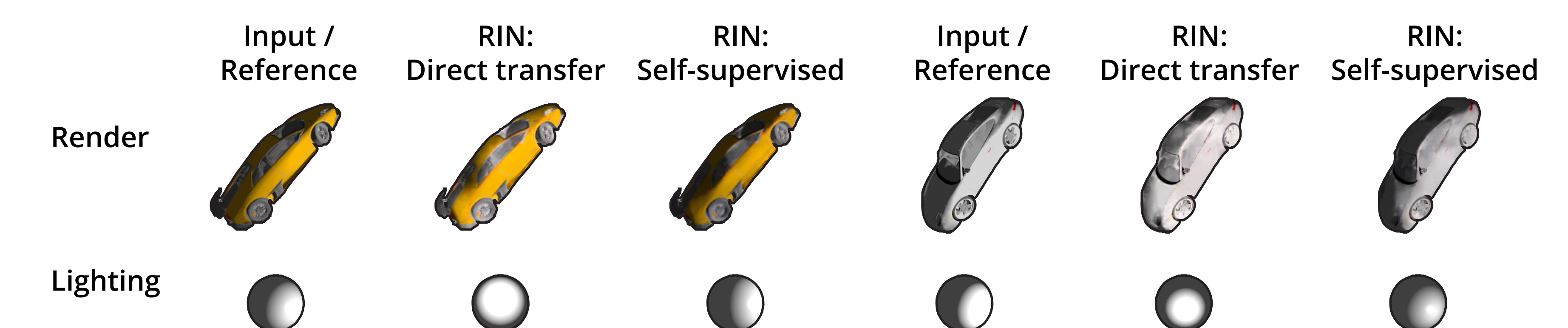
- RIN decoders were transferred to new **shapes**, **lighting conditions**, and **objects** without labels for the transfer images
- Using entire decomposition-reconstruction pipeline, relevant decoders were trained to improve reconstructions of unlabeled images while the rest of RIN was held fixed

Shape

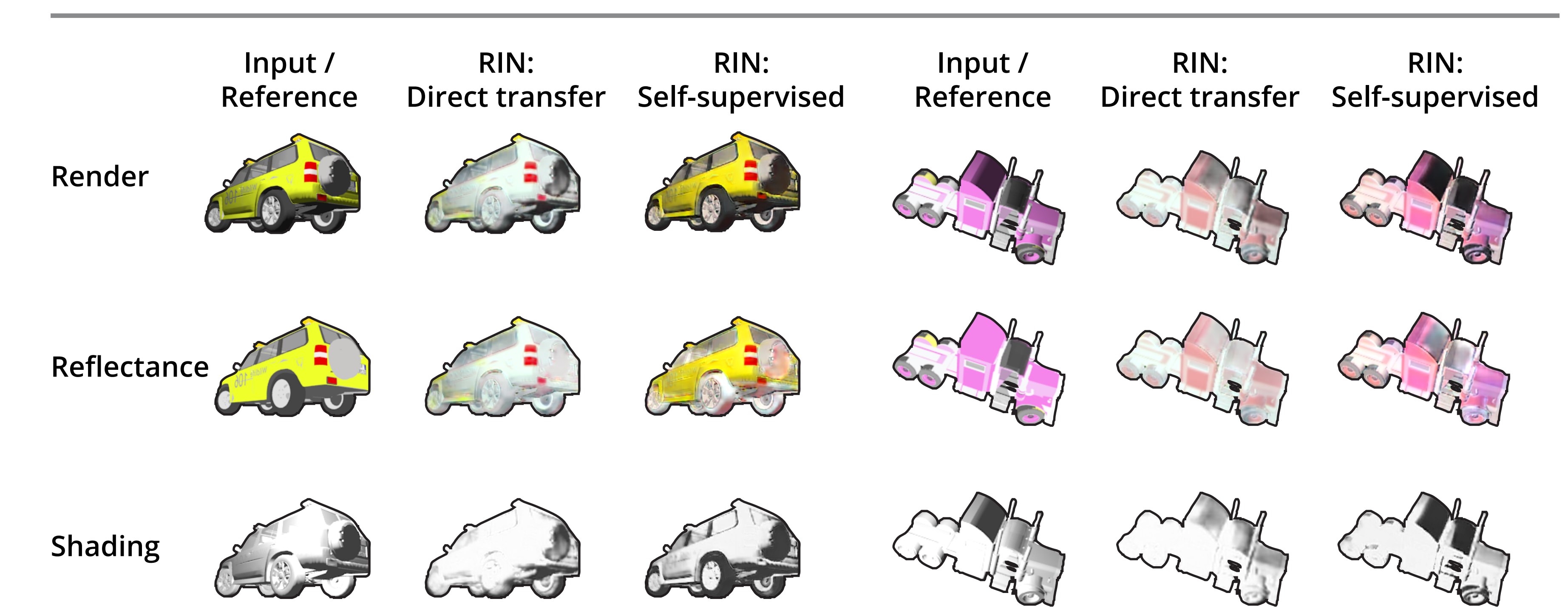


	Stanford Bunny		Utah Teapot		Blender Suzanne	
	Shape	Shading	Shape	Shading	Shape	Shading
Direct transfer	0.074	0.071	0.036	0.043	0.086	0.104
Self-supervised	0.048	0.005	0.029	0.003	0.058	0.007

Lighting



Category



	Reflectance	Shape	Lights	Shading	Render
Direct transfer	0.019	0.014	0.584	0.065	0.035
Self-supervised	0.015	0.014	0.572	0.044	0.006