Towards Unsupervised Learning of Generative Models for 3D Controllable Image Synthesis

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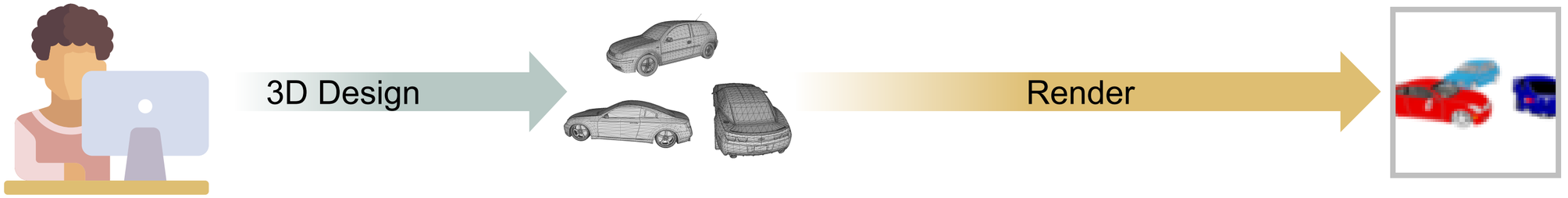
Motivation

3D Controllable Image Synthesis

- 3D controllability is essential in many applications, e.g., gaming, simulation, virtual reality and data augmentation
- 3D controllable properties: 3D pose, shape, appearance of multiple objects and camera viewpoint

Motivation

Classical Rendering Pipeline

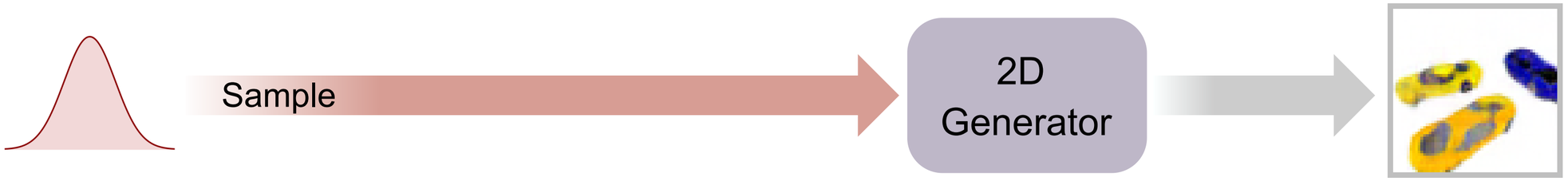


+ 3D Controllable

− Expensive and inefficient to design 3D models

Motivation

2D Generative Models

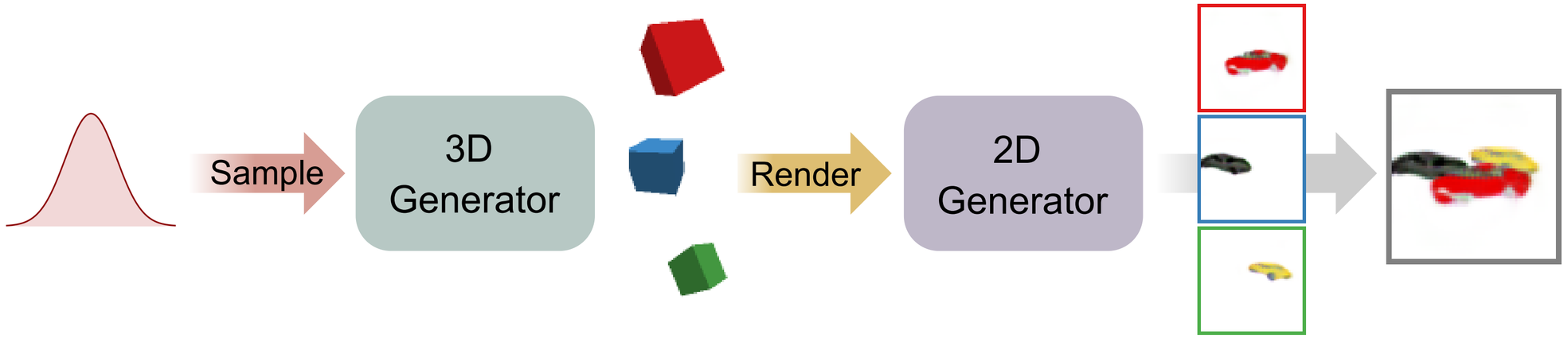


+ Efficient, learned from only 2D images

− Geometry and appearance not disentangled → no 3D control

Motivation

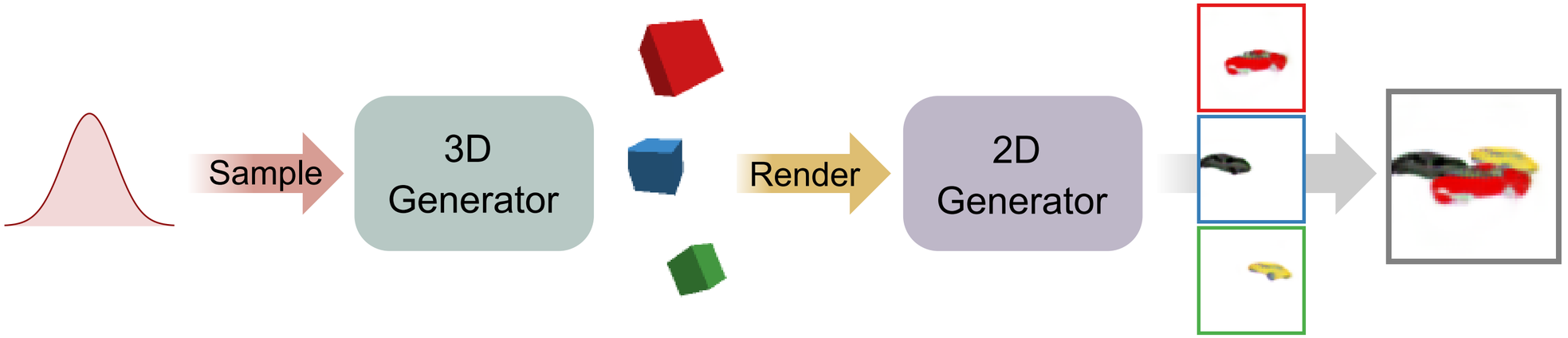
Ours



- 3D Controllable
- Efficient, learned from only 2D images
- Unsupervised, disentangled 3D representation learning

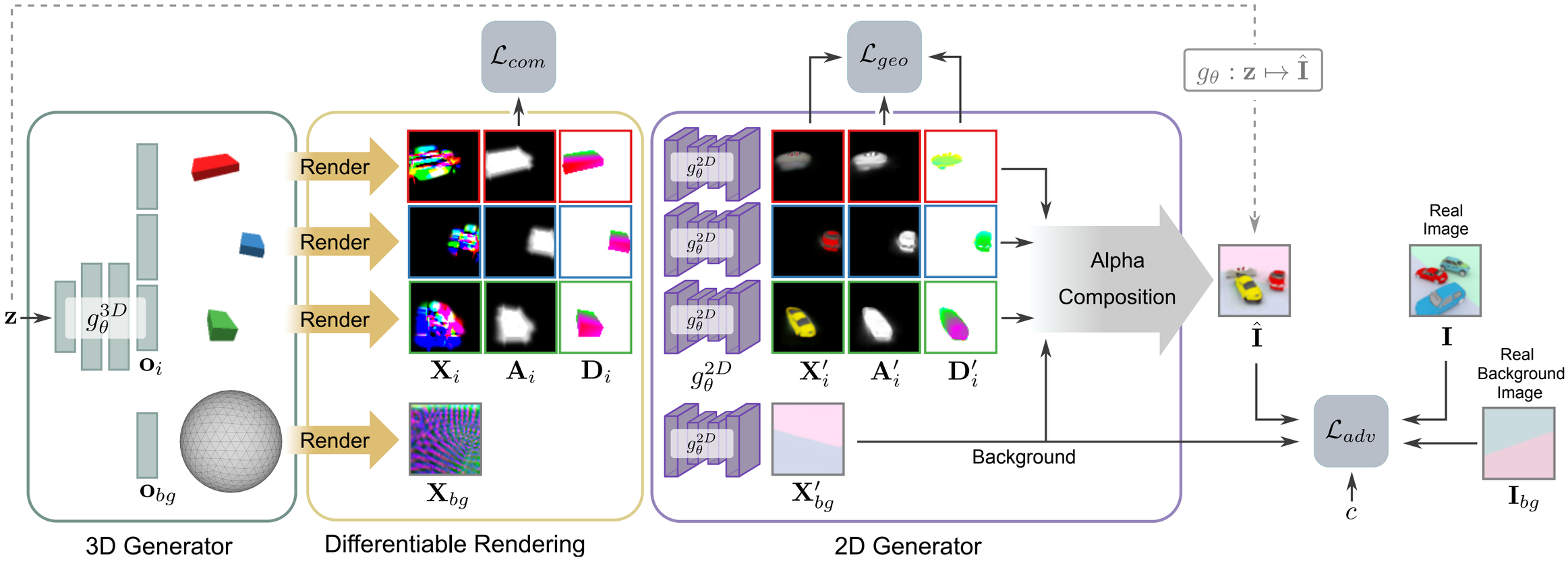
Motivation

Ours



Idea: Learning the image synthesis pipeline jointly in 3D and 2D space

Method Overview



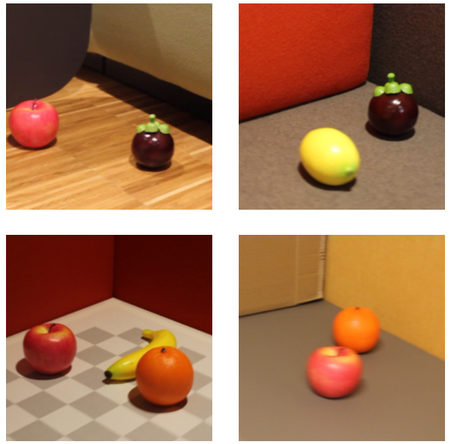
Experiments

Datasets

Car w/o BG

Car with BG

Indoor

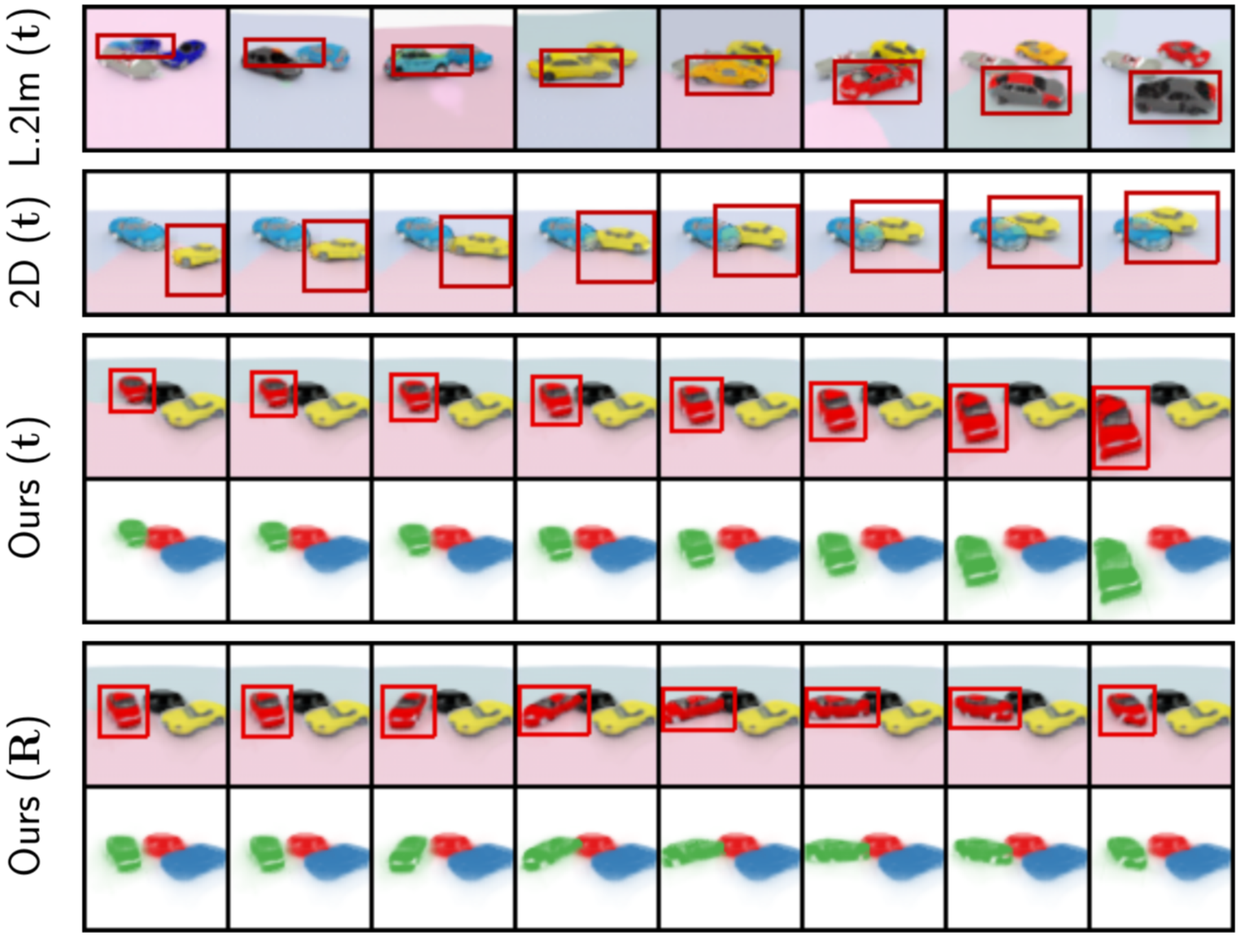


Fruit

Experiments

Car Dataset

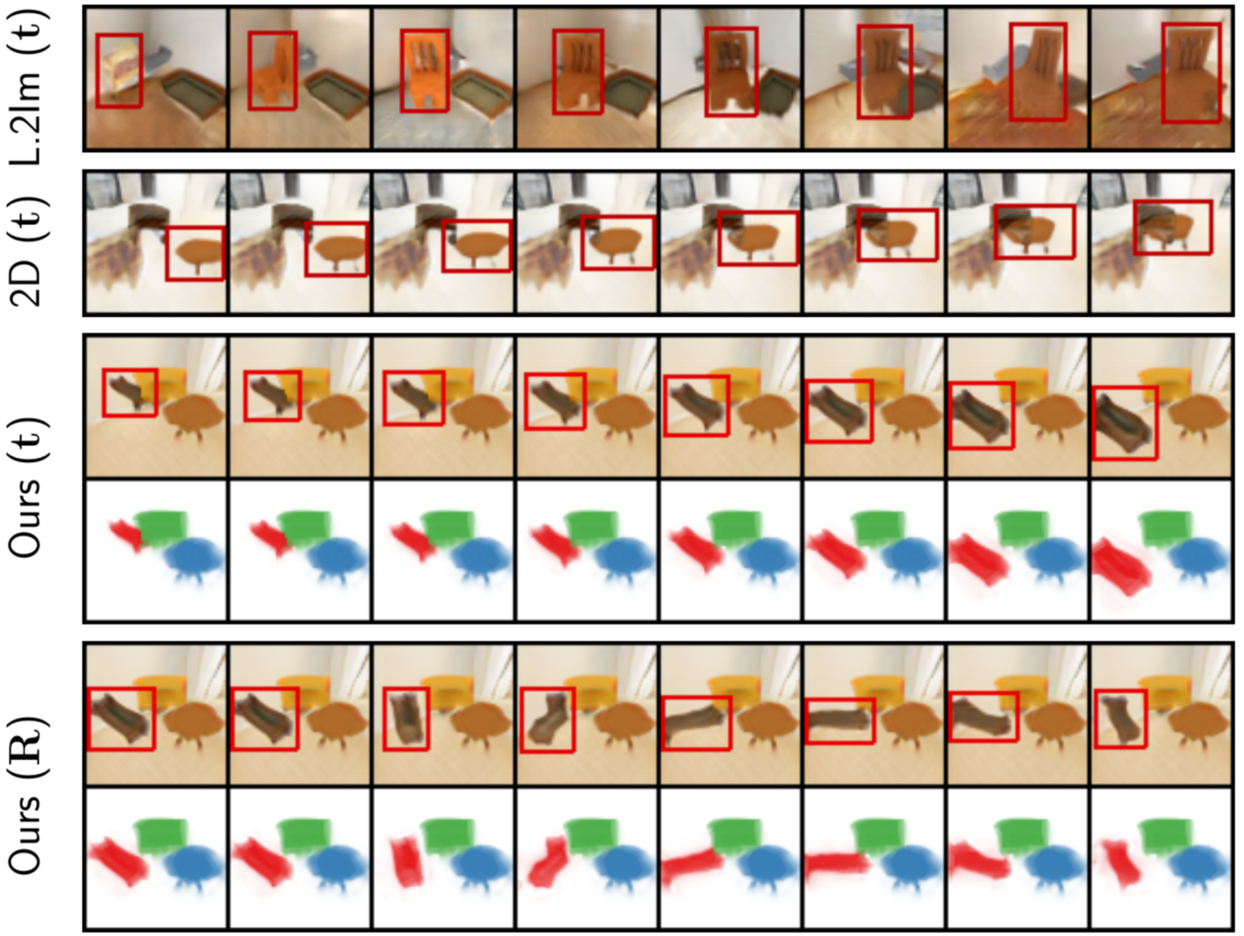
- Layout2Im and our 2D baseline are only controllable for 2D translation
- Layout2Im fails to disentangle object identity and pose
- Our method is controllable for 3D translation and rotation with coherent object identity



Experiments

Indoor Dataset

- Layout2Im and our 2D baseline are only controllable for 2D translation
- Layout2Im fails to disentangle object identity and pose
- Our method is controllable for 3D translation and rotation with coherent object identity

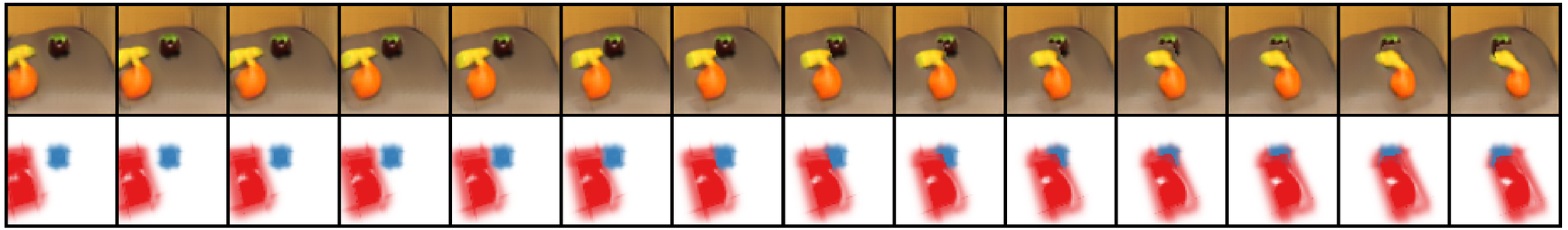


Experiments

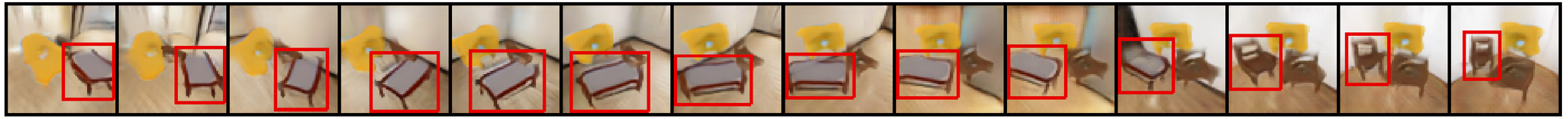
Fruit Dataset

- We collect 800 images with 5 fruits and 5 backgrounds
- Our method is able to synthesize plausible images from real data

Failure Cases



A single primitive generates multiple objects occasionally



Identity might flip wrt. large viewpoint change

Stronger inductive biases are required
to tackle these problems


Thank you!