

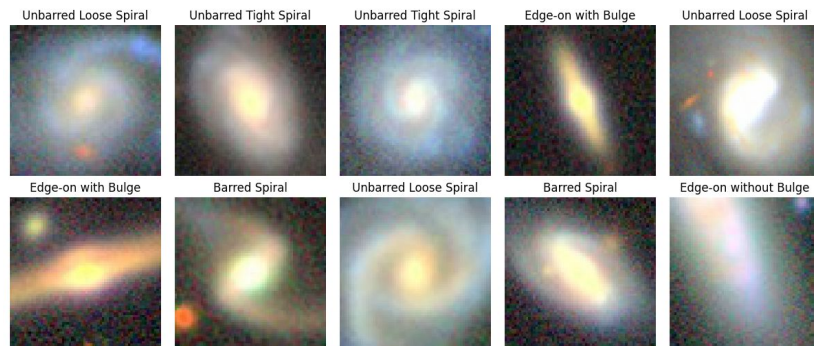
Milky Way Challenge

Normalizing flows

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Modified Galaxy10 DECals Dataset

- Images from DESI Legacy Imaging Surveys (optical and infrared)
- 256x256 RGB
- Classified into 10 classes by volunteers by voting
- We use only 5 of the classes:
 - Barred Spiral n=2043
 - Unbarred Tight Spiral n=1829
 - Unbarred Loose Spiral n=2628
 - Edge-on without Bulge n=1432
 - Edge-on with Bulge n=1873
 - total: 9805 images
- We crop to 64x64, most parts of the galaxies are within this crop
- Rescaled from [0-255] to [0,1]



Milky Way image

- Artist's impression based on structure estimates using Spitzer Space Telescope
- RGB
- Reduced resolution to 64x64
- Rescaled from [0-255] to [0,1]
- Different kind of image than Galaxy10 DeCals



Neural Network Architecture

- Two architectures were explored:

Normalizing Flows

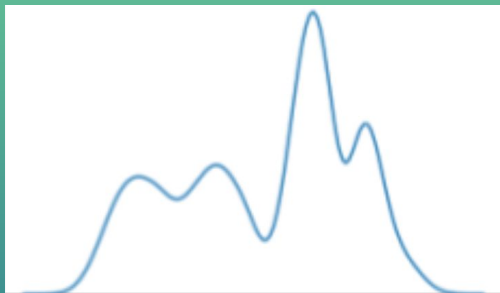
- use flows to generate new images and evaluate the likelihood of the target and the other images from the dataset

Autoencoders

- Compare the distance between target and dataset images in latent space

Flow architecture

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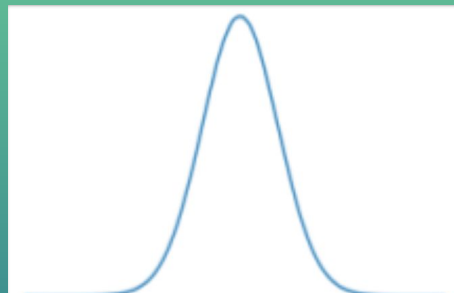


Given Galaxy Images

4 affine flow layers



Package:
jammy flows



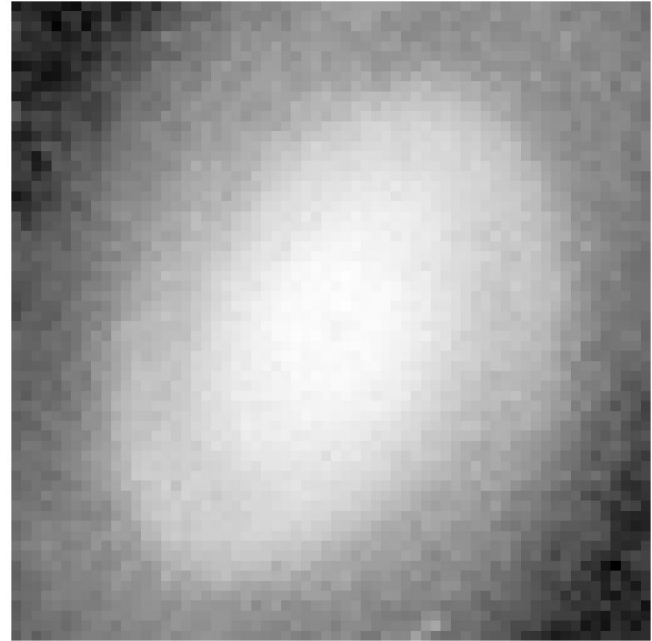
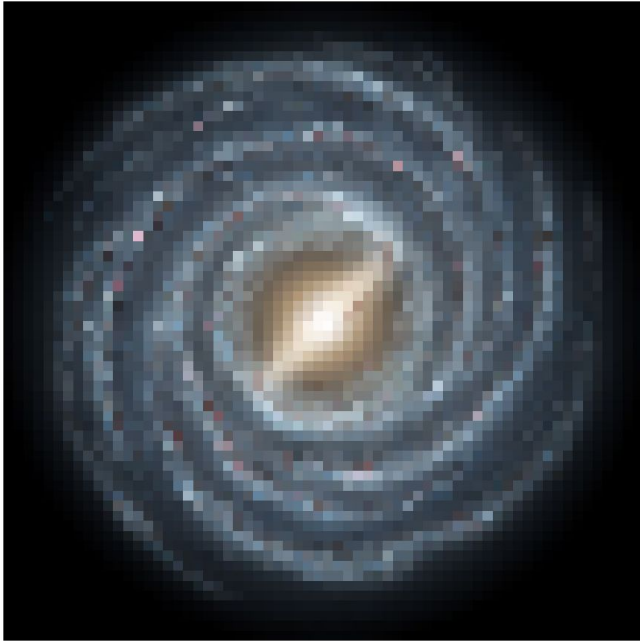
Latent Space

Idea:

Put Milky Way image and sample galaxy pictures into the trained flow and compare log likelihood in the latent space

→ closest likelihood images should be most similar to Milky Way

Images generated with the flow architecture



Autoencoder architecture

Encoder

Galaxy image input

conv 2d

5 ×
Residual block x 6

maxpool

Flatten

Dense layer

Sigmoid

Decoder

Dense layer

unflatten

5 ×
Residual block

upsample

conv 2d

Output

Residual block

input

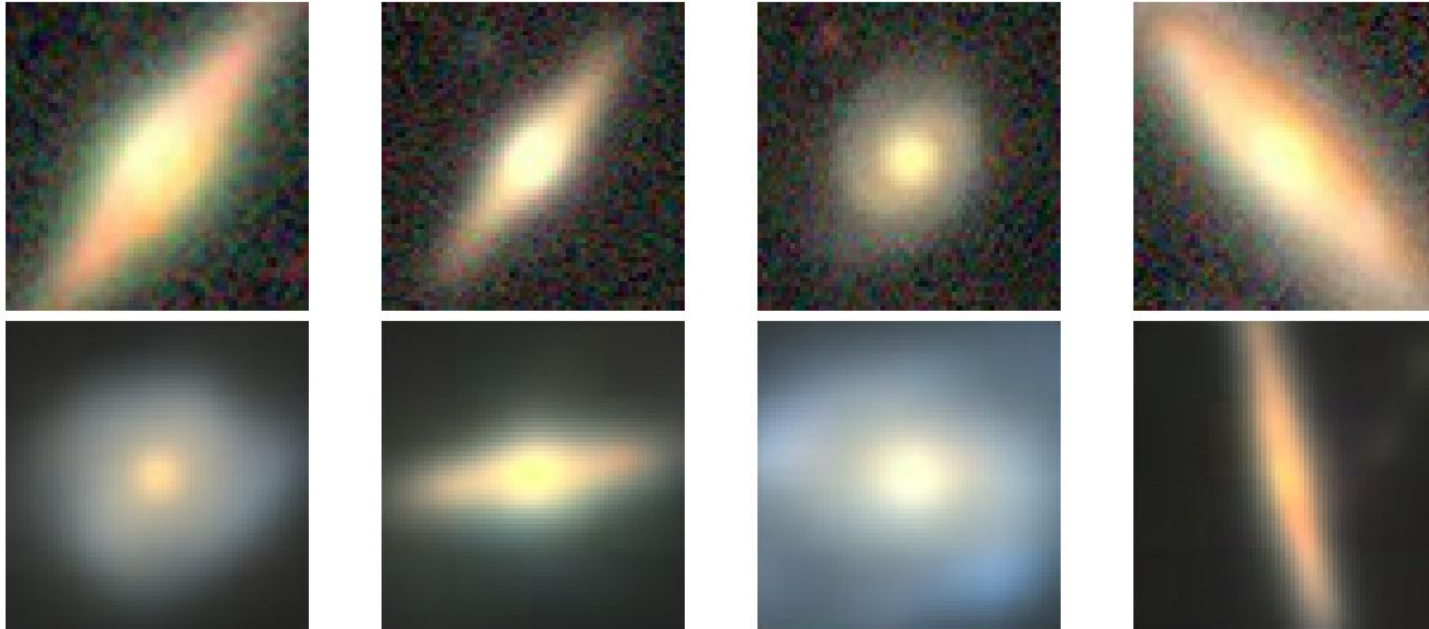
Convolution

Convolution

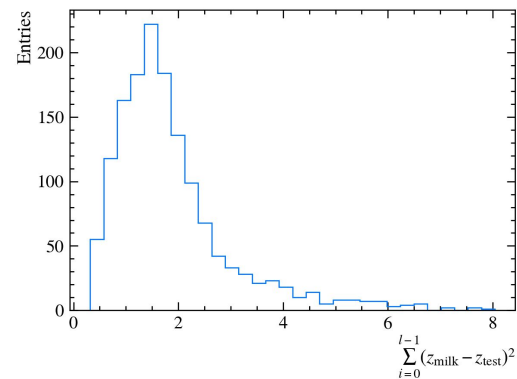
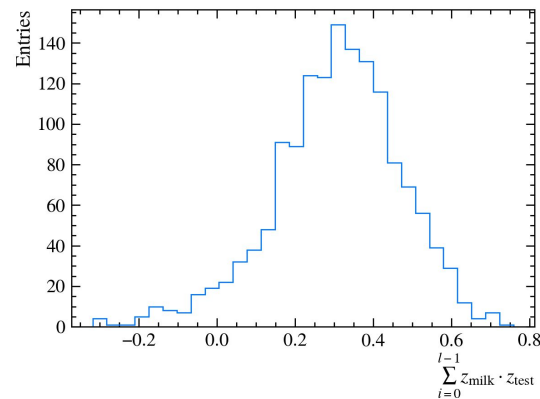
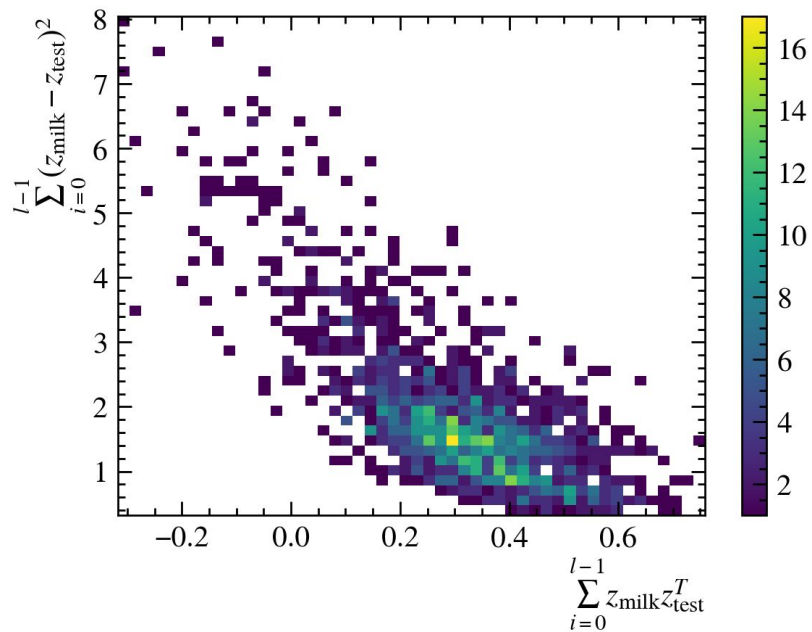
+ × α

Autoencoder Results

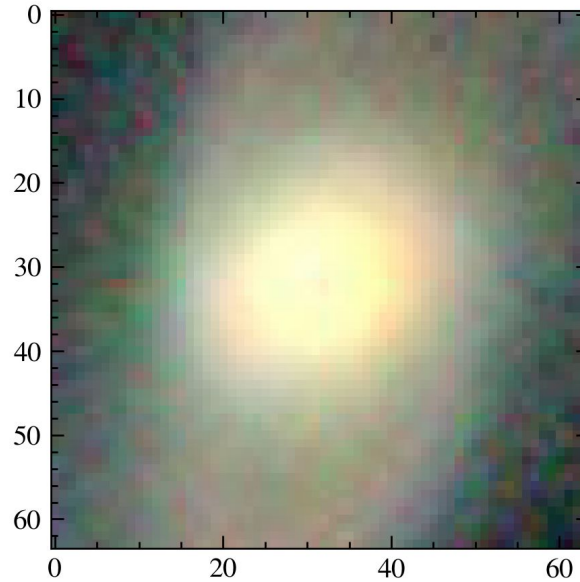
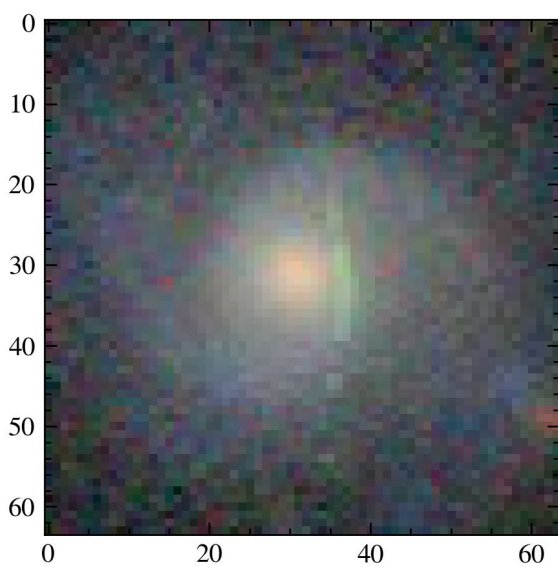
Performance of the autoencoder in reconstructing the images



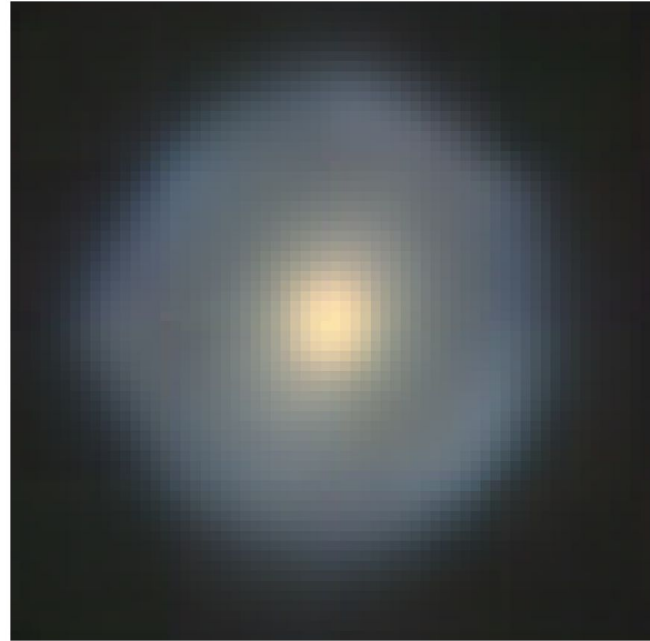
“Nearest” image in the latent space



“Nearest” image in the latent space



Autoencoder output of the target image



backup slides

