Generating galaxies with deep convolutional generative adversarial networks

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Galaxy generation

Galaxy catalogues

Galaxy generation

Galaxy catalogues

- Mock catalogues

Galaxy generation

Galaxy catalogues

- Mock catalogues
- Pipeline development

Galaxy generation

Galaxy catalogues

- Mock catalogues
- Pipeline development

Galaxy information

- Redshift

Galaxy generation

Galaxy catalogues

- Mock catalogues
- Pipeline development

Galaxy information

- Redshift
- Position

Galaxy generation

Galaxy catalogues

- Mock catalogues
- Pipeline development

Galaxy information

- Redshift
- Position
- Size

Galaxy generation

Galaxy catalogues

- Mock catalogues
- Pipeline development

Galaxy information

- Redshift
- Position
- Size
- Luminosity

Galaxy generation

Galaxy catalogues

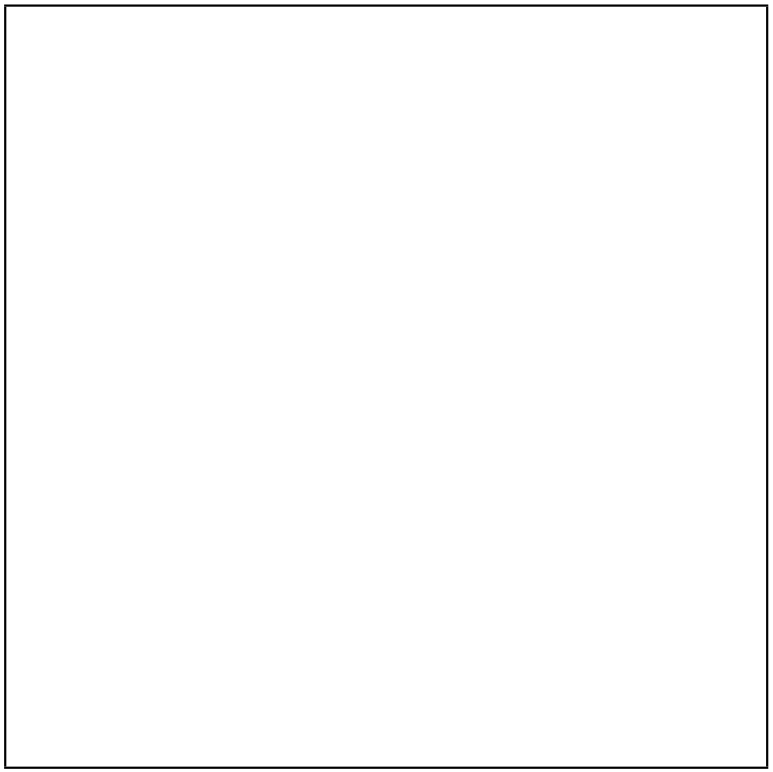
- Mock catalogues
- Pipeline development

Galaxy information

- Redshift
- Position
- Size
- Luminosity
- Image

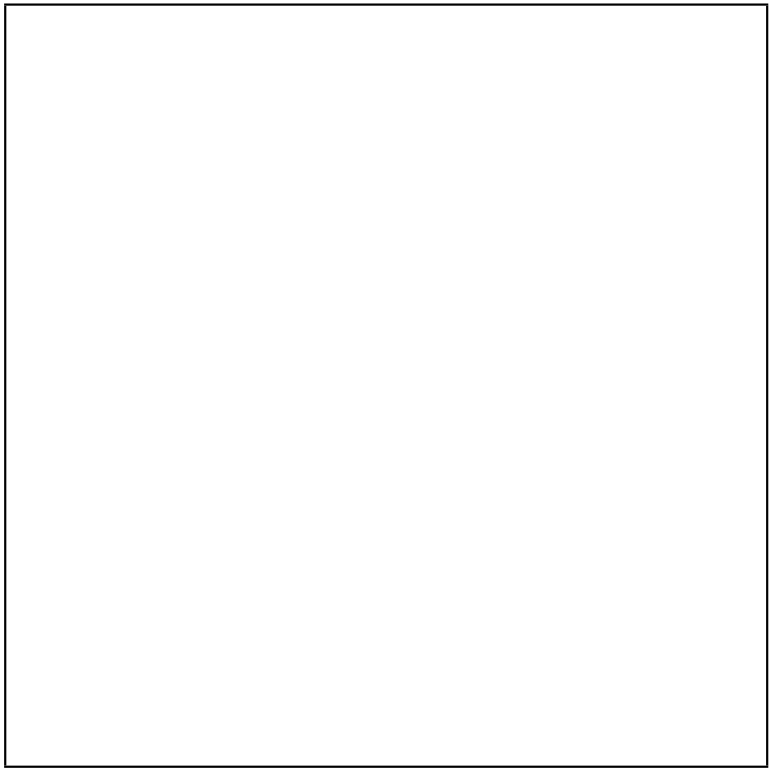
Galaxy generation

Galaxy generation



Galaxy generation

Galaxy generation



Galaxy generation

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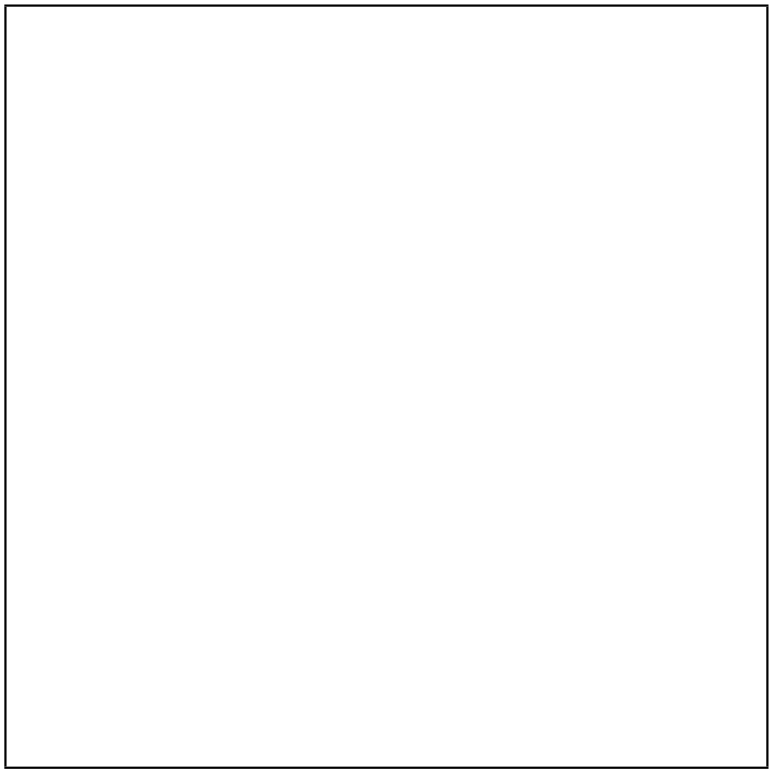

Galaxy generation

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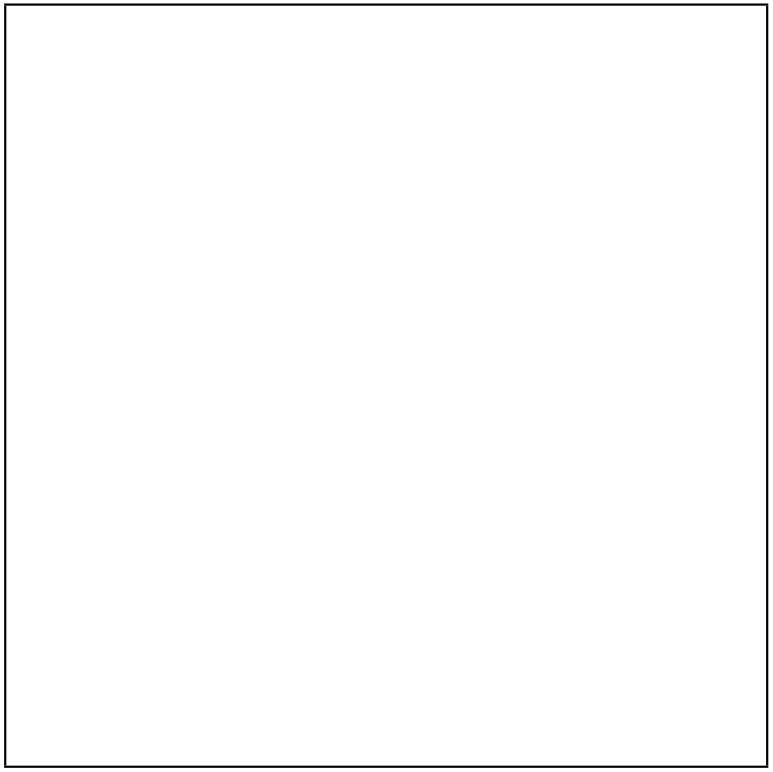
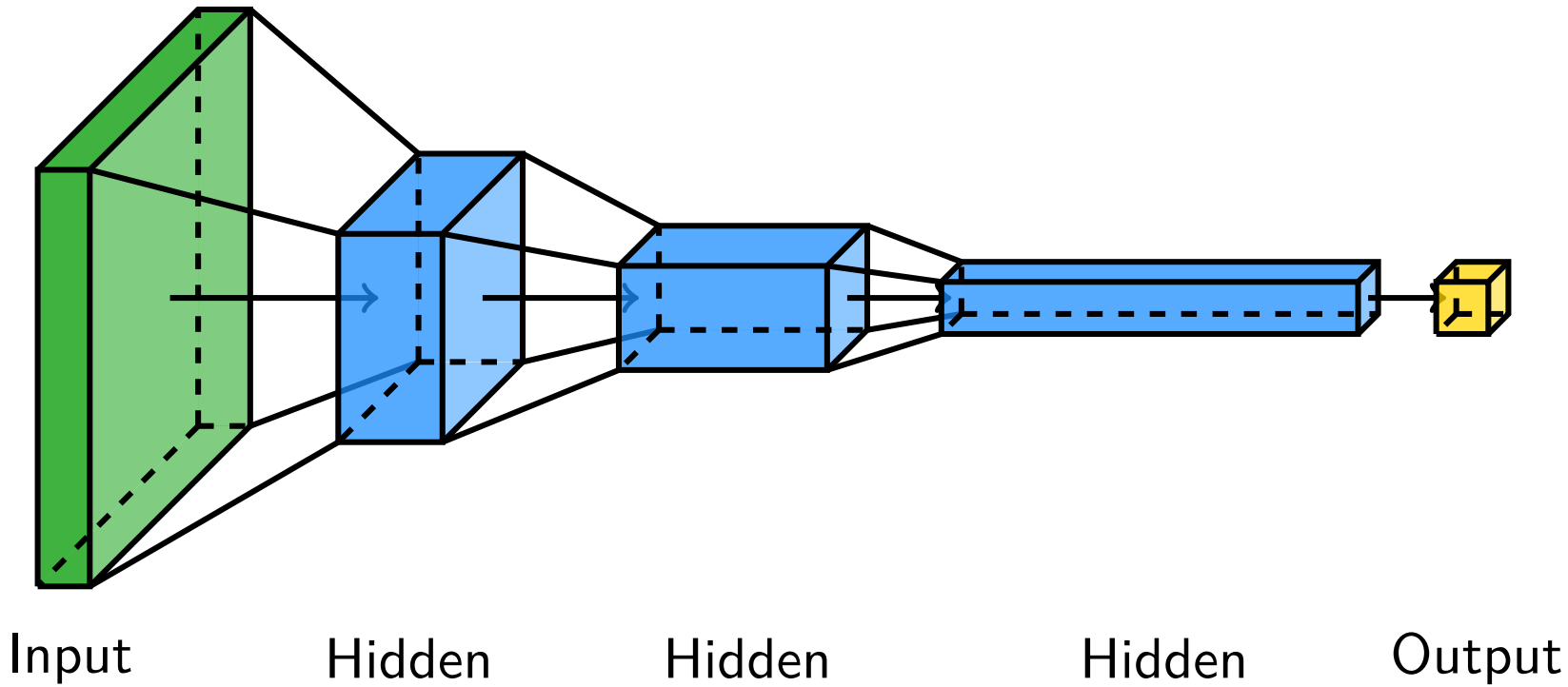


Neural networks

Convolutional neural network

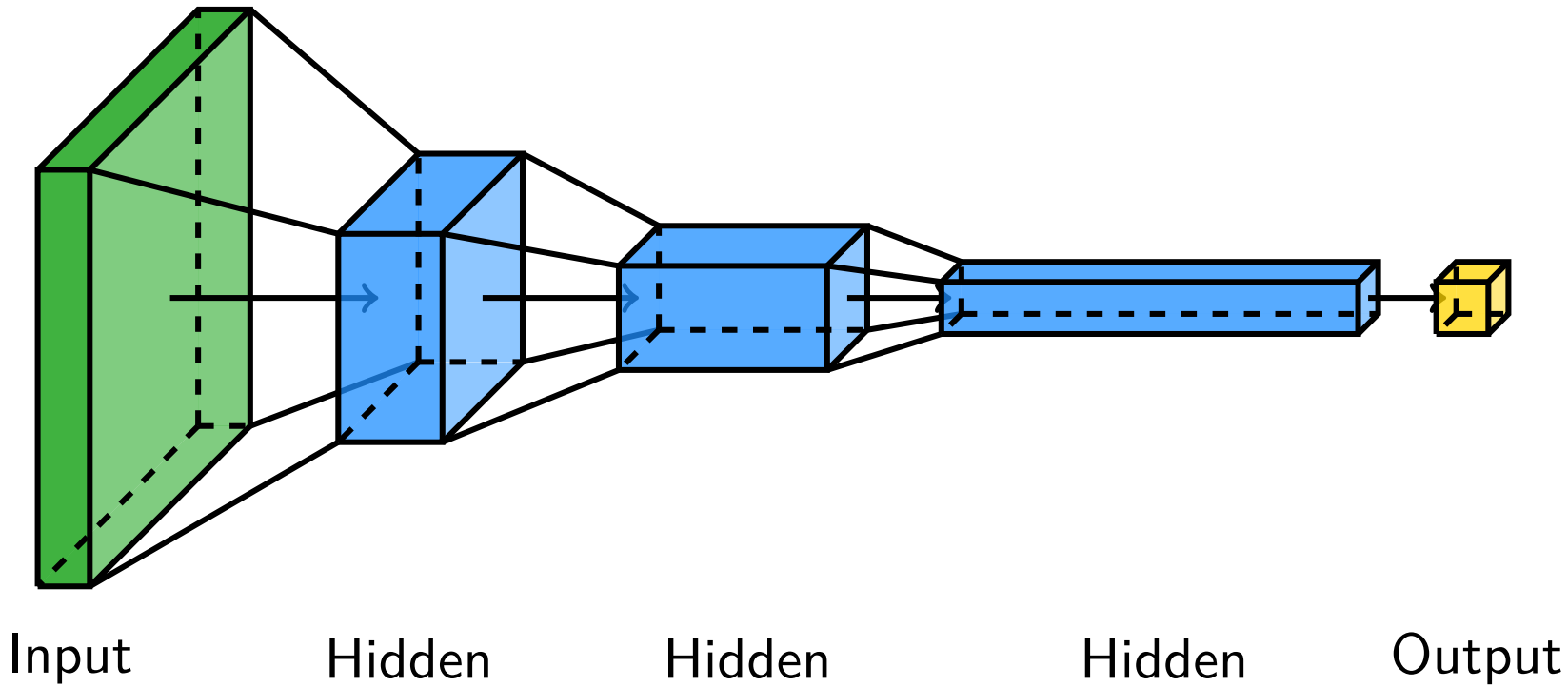


Discriminator

- Takes an image

Neural networks

Convolutional neural network

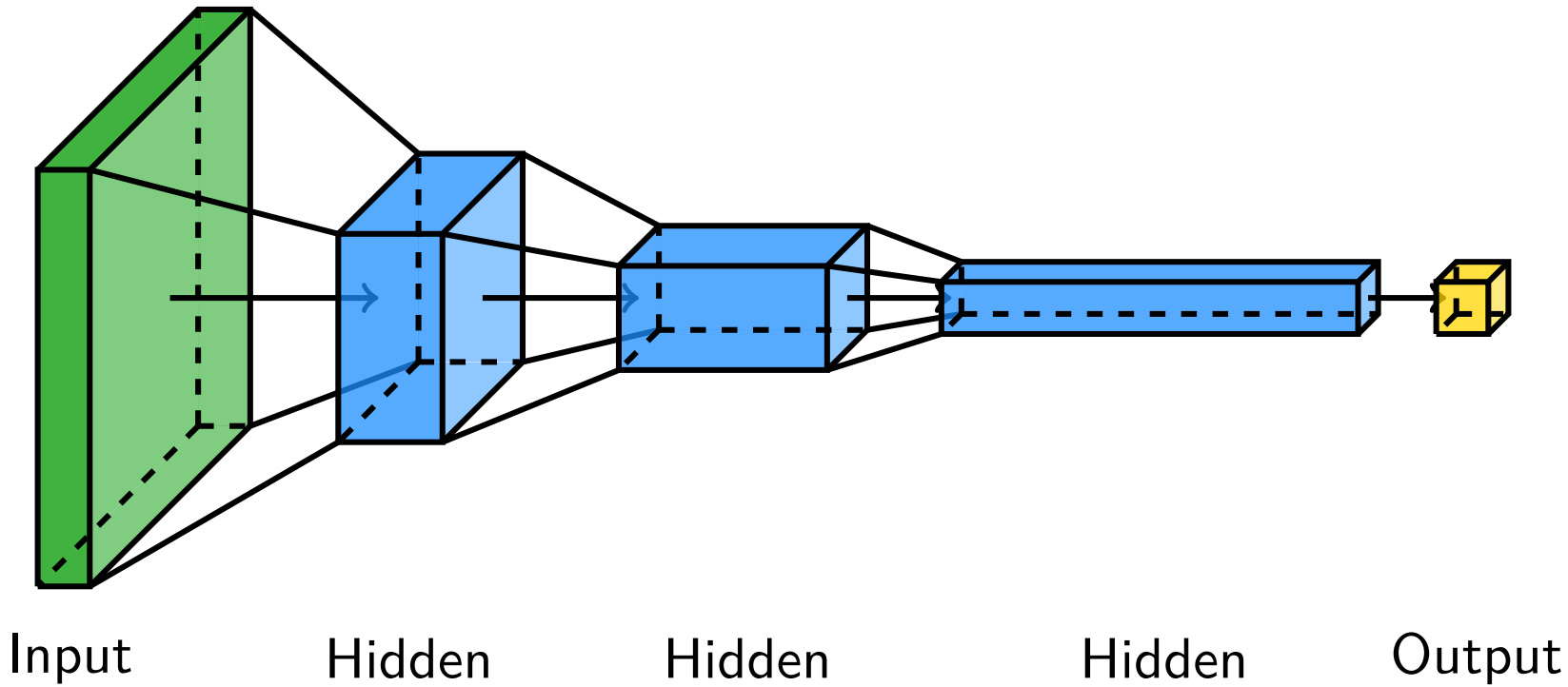


Discriminator

- Takes an image
- Uses convolution to extract features

Neural networks

Convolutional neural network

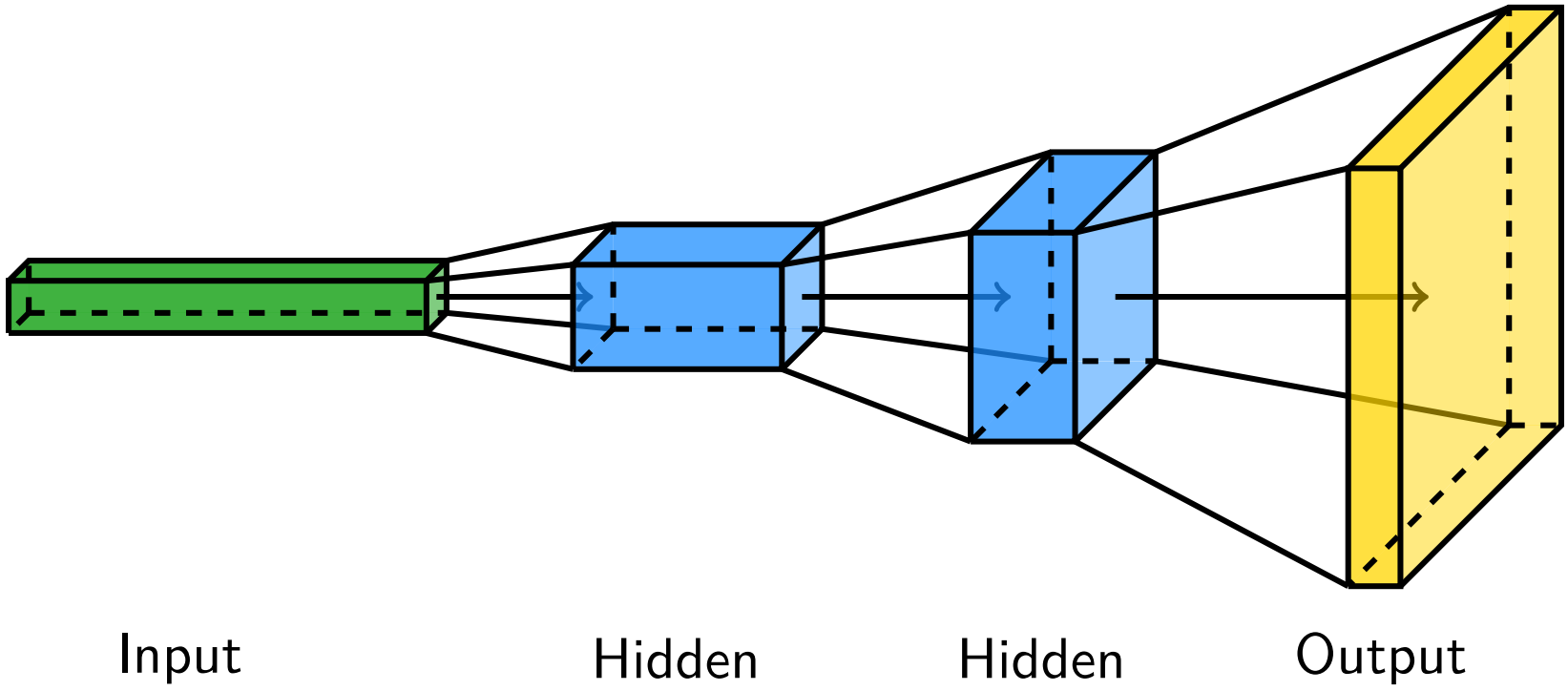


Discriminator

- Takes an image
- Uses convolution to extract features
- Classifies the image

Neural networks

Convolutional neural network

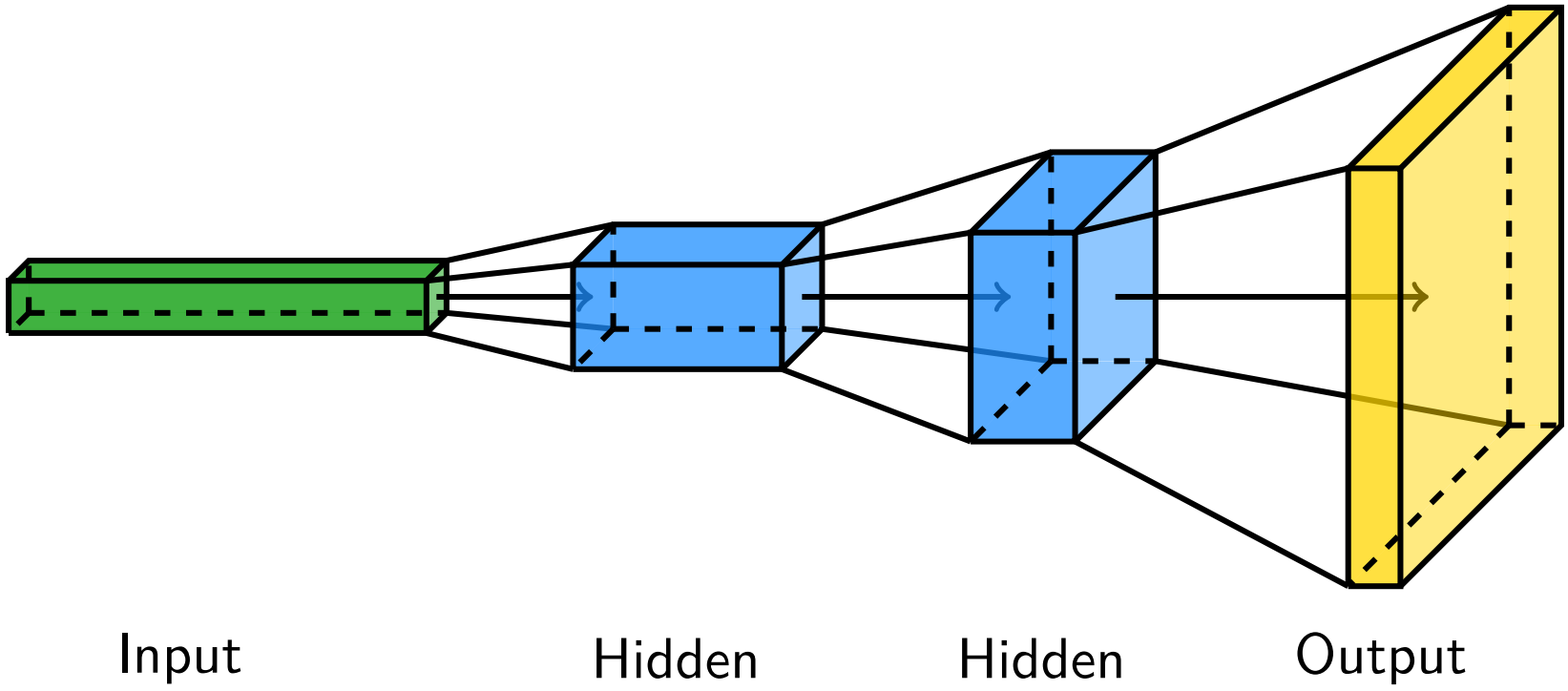


Generator

- Takes a random array

Neural networks

Convolutional neural network

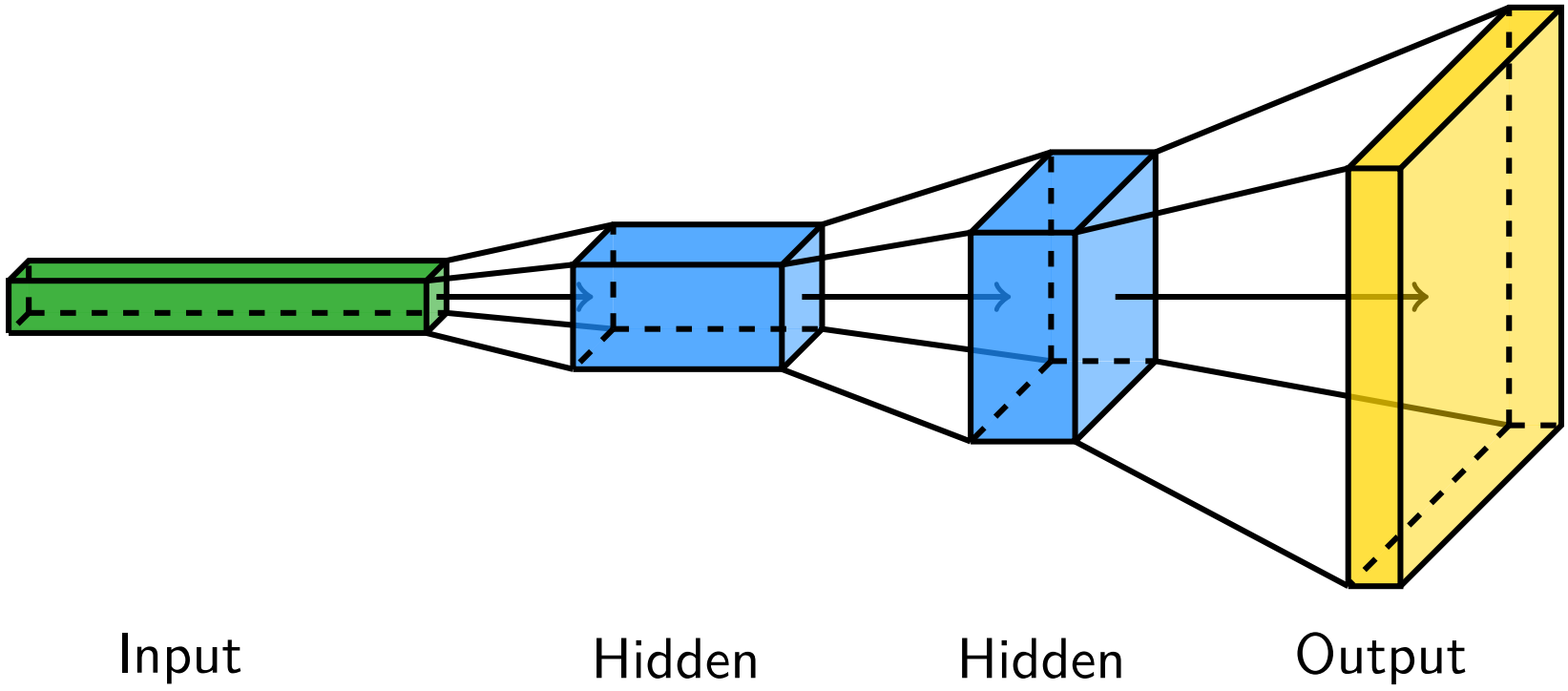


Generator

- Takes a random array
- Fractionally-strided convolutions to create features

Neural networks

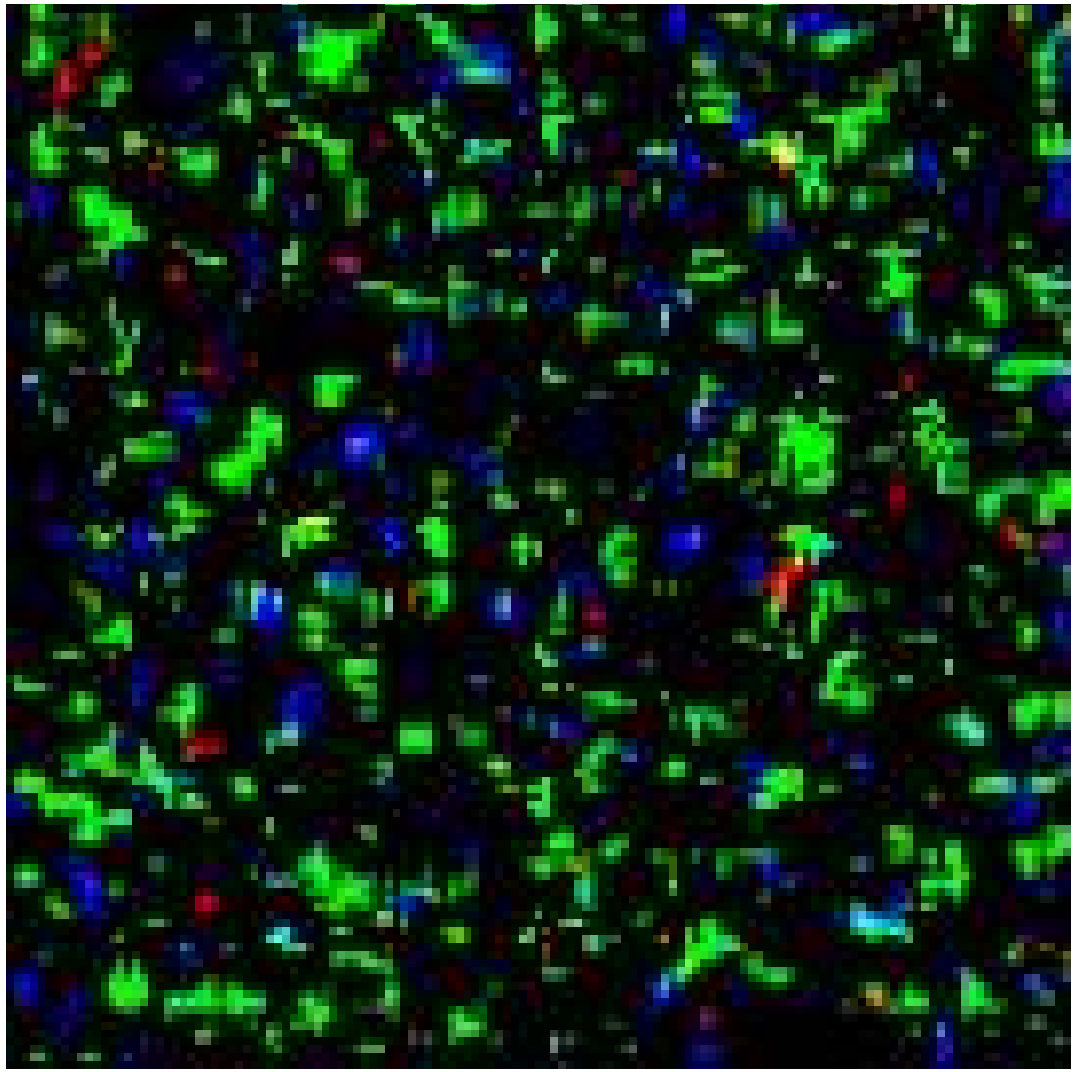
Convolutional neural network



Generator

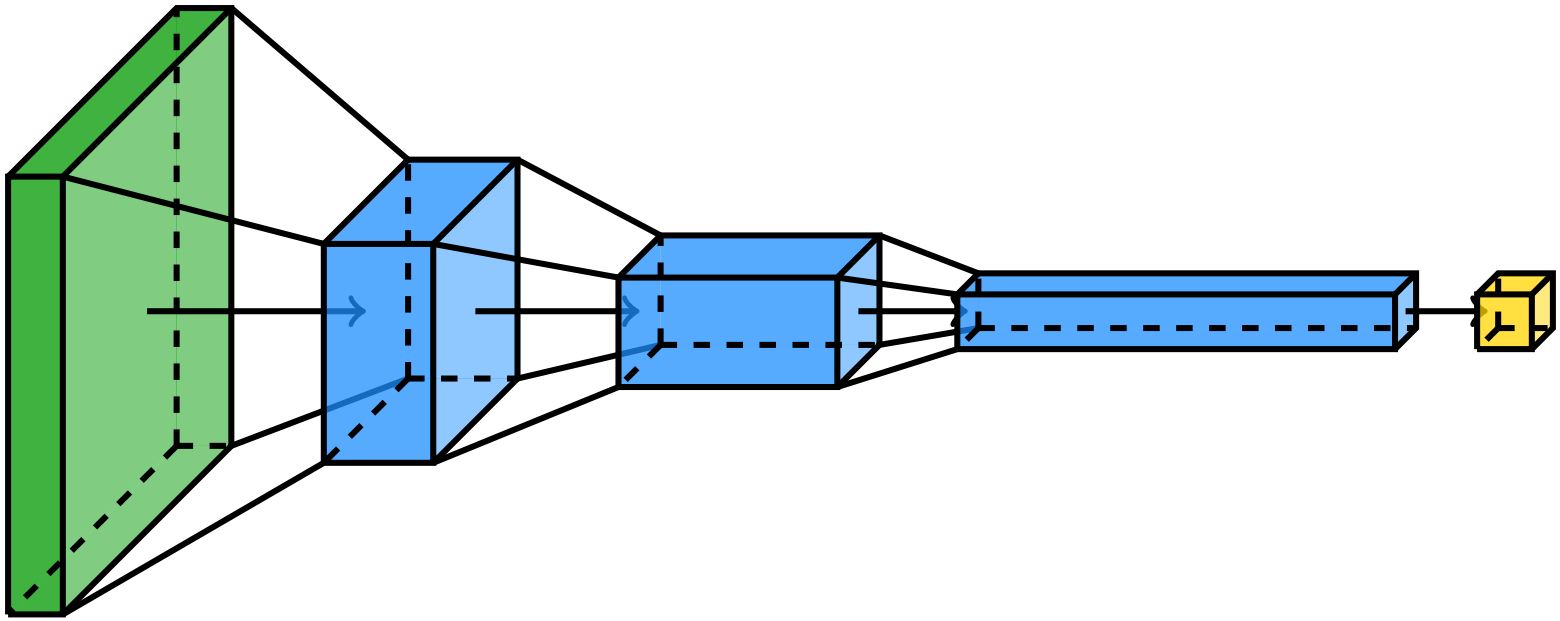
- Takes a random array
- Fractionally-strided convolutions to create features
- Generates image

Untrained generated galaxy



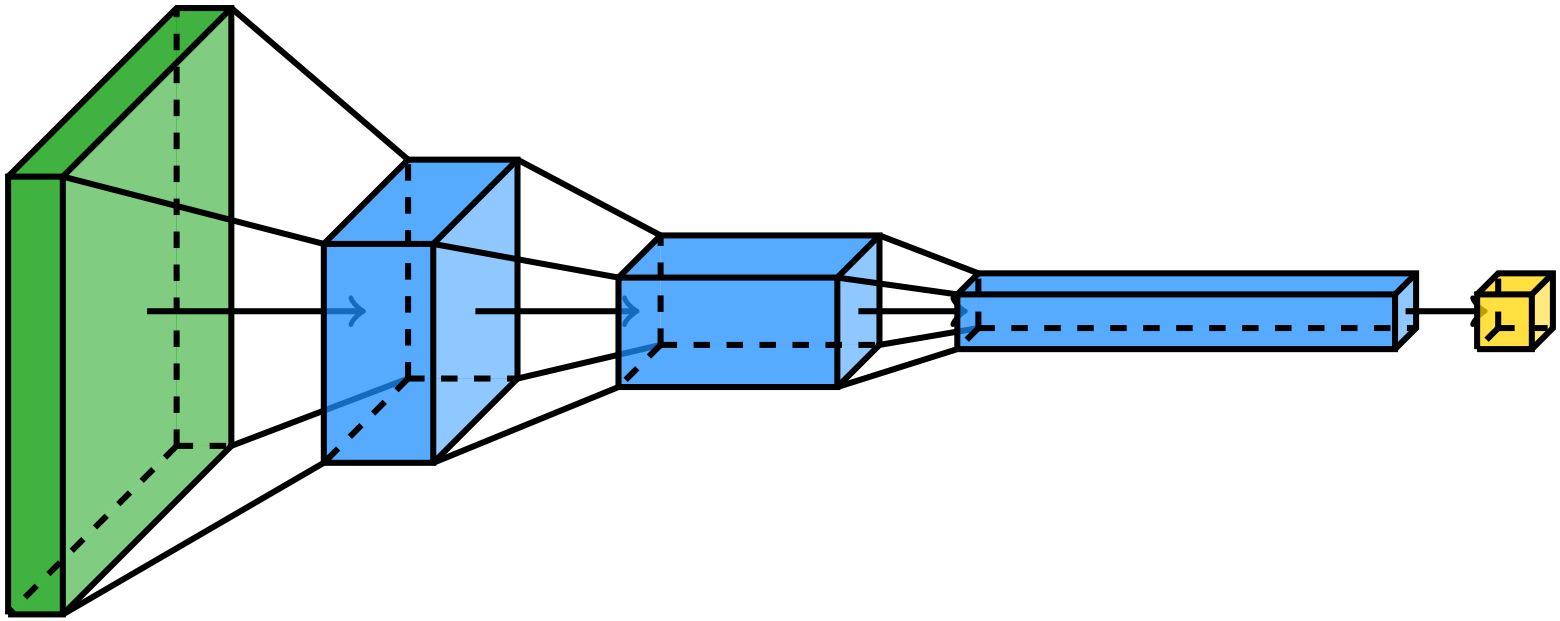
How to generate a galaxy

Discriminator



How to generate a galaxy

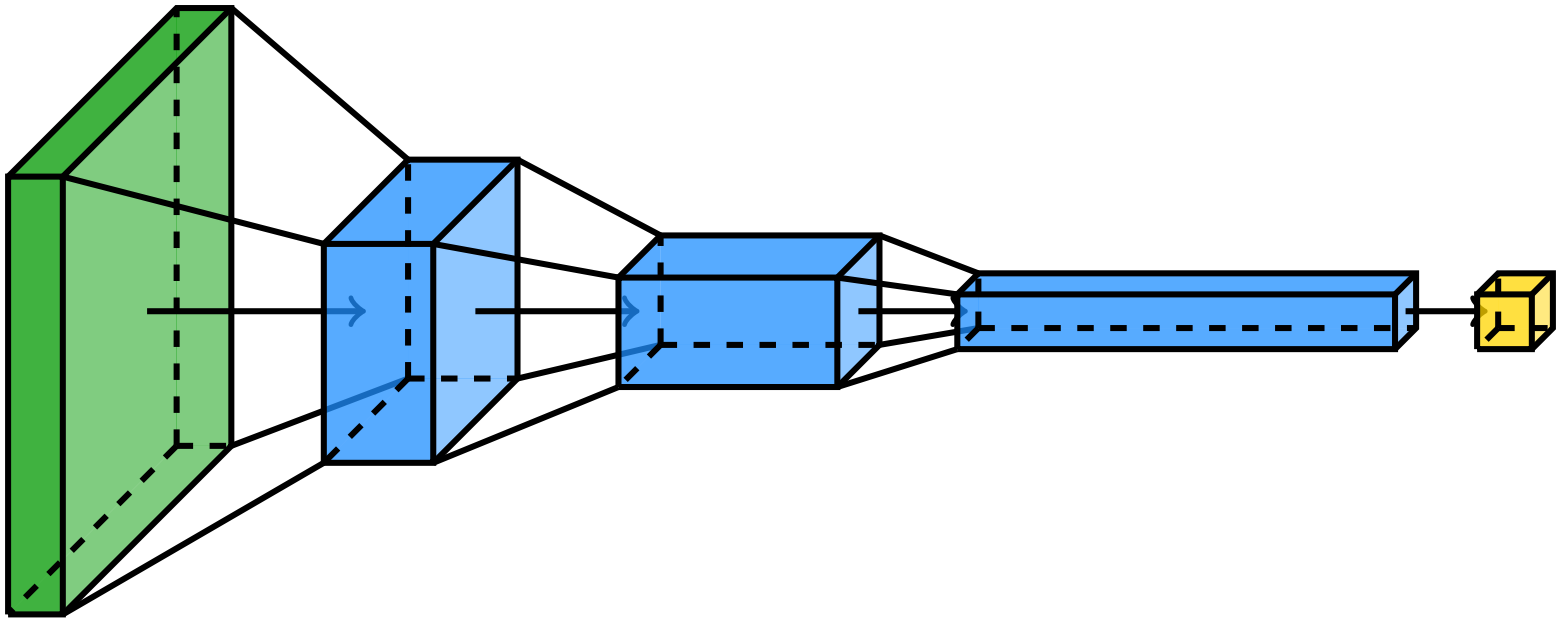
Discriminator



- Collect n real images
- Label *real*

How to generate a galaxy

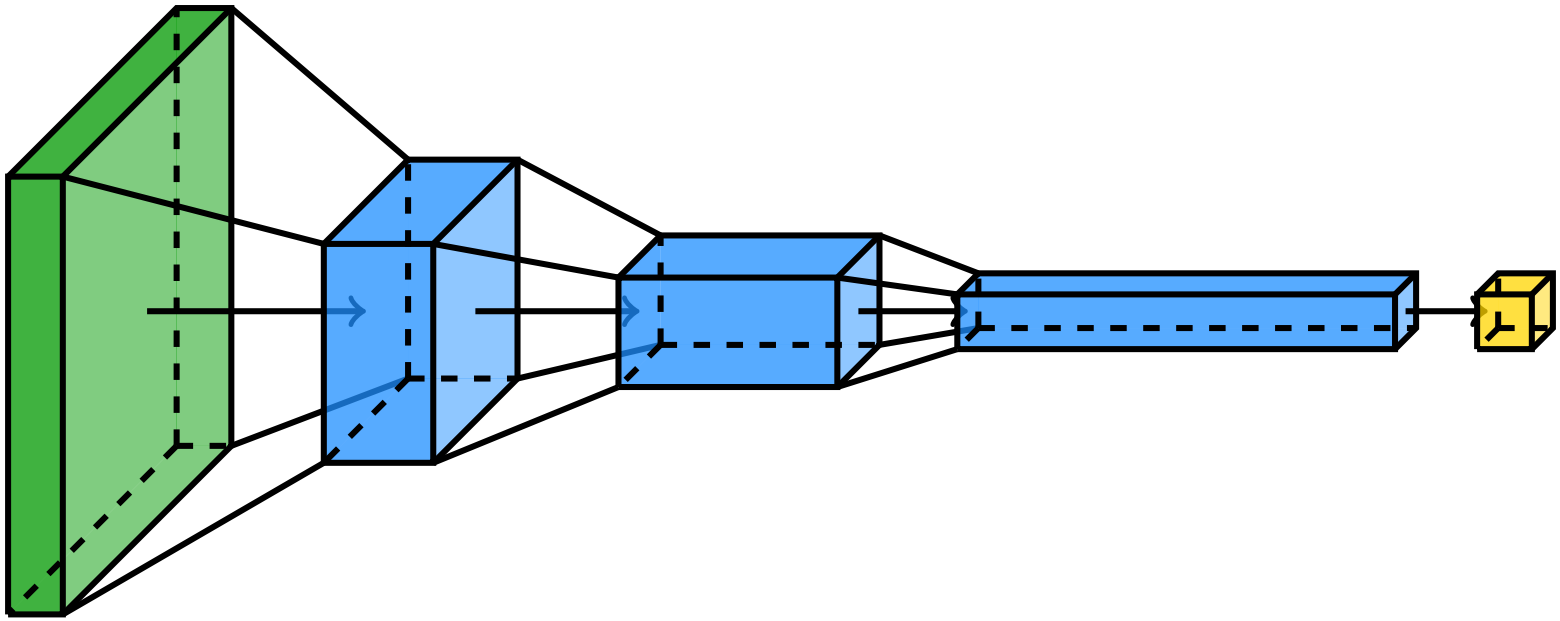
Discriminator



- Collect n real images
- Label *real*
- Generate n fake images
- Label *fake*

How to generate a galaxy

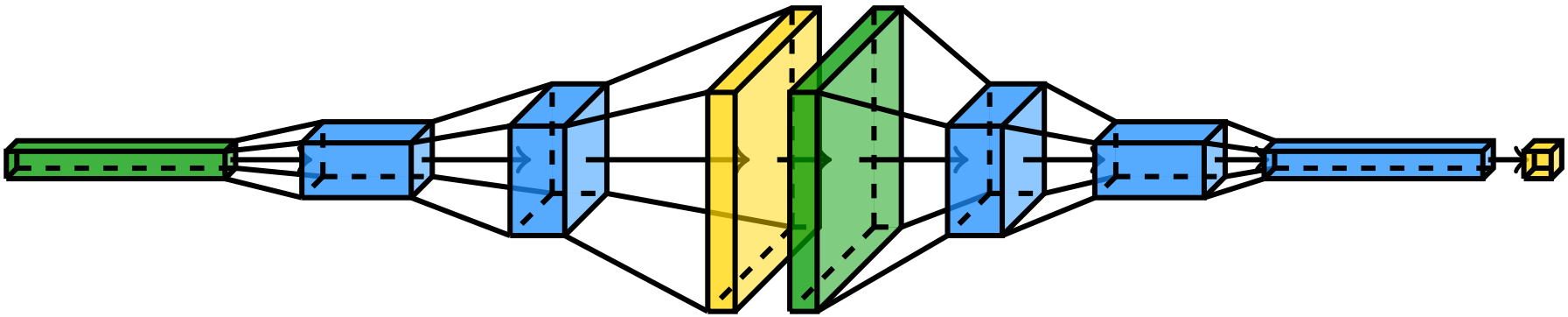
Discriminator



- Collect n real images
- Label *real*
- Generate n fake images
- Label *fake*
- Train using categorical cross-entropy

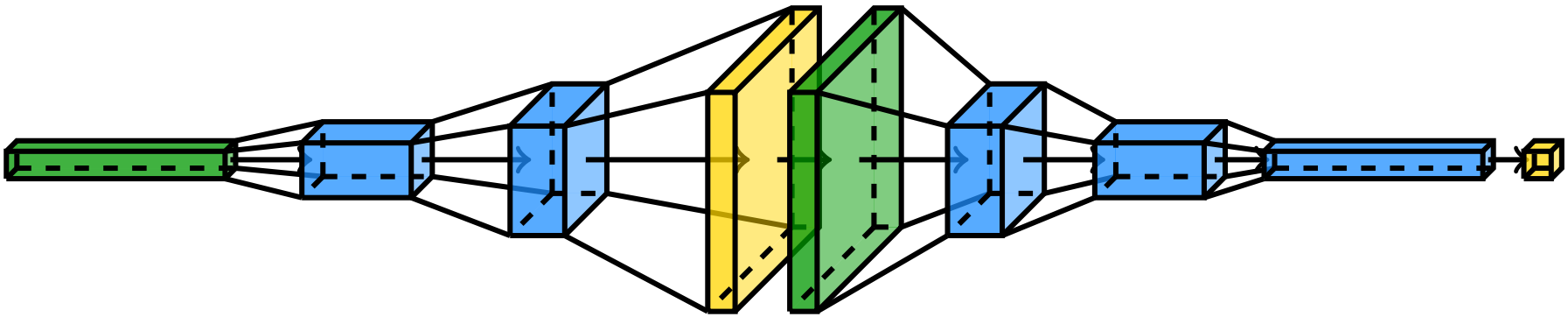
How to generate a galaxy

Deep convolutional generative adversarial network



How to generate a galaxy

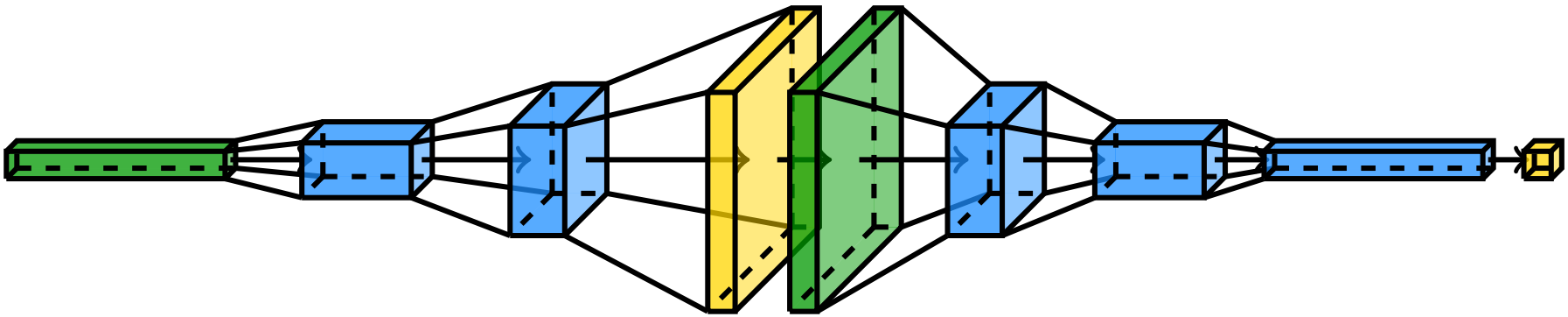
Deep convolutional generative adversarial network



- Generate n random arrays
- Label *real*

How to generate a galaxy

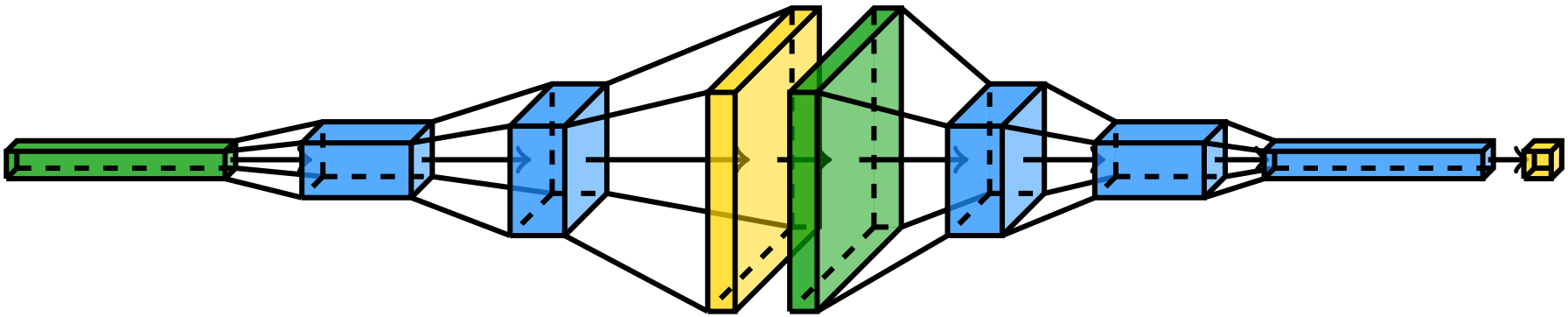
Deep convolutional generative adversarial network



- Generate n random arrays
- Label *real*
- Freeze weights in discriminator

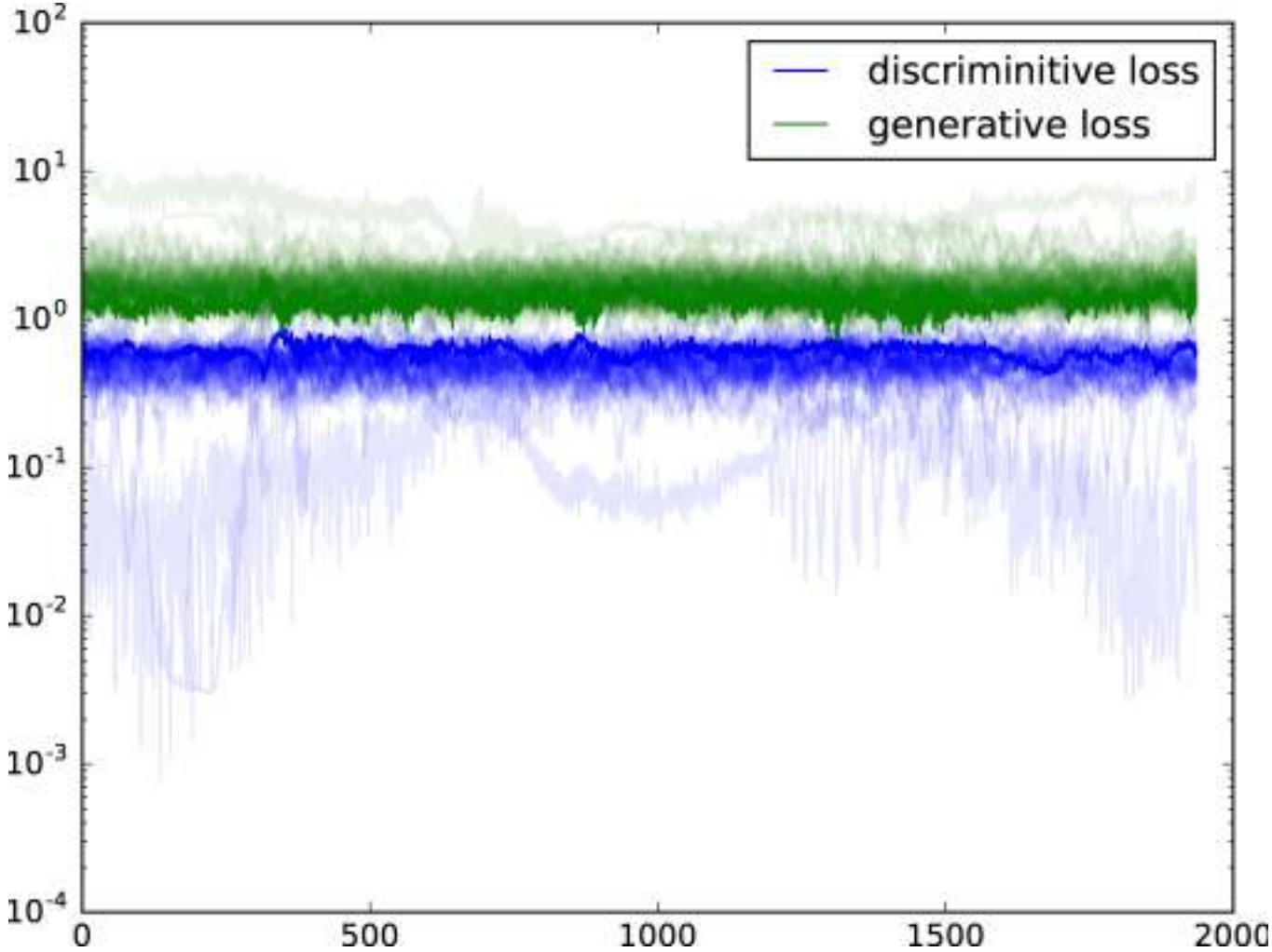
How to generate a galaxy

Deep convolutional generative adversarial network



- Generate n random arrays
- Label *real*
- Freeze weights in discriminator
- Train using categorical cross-entropy

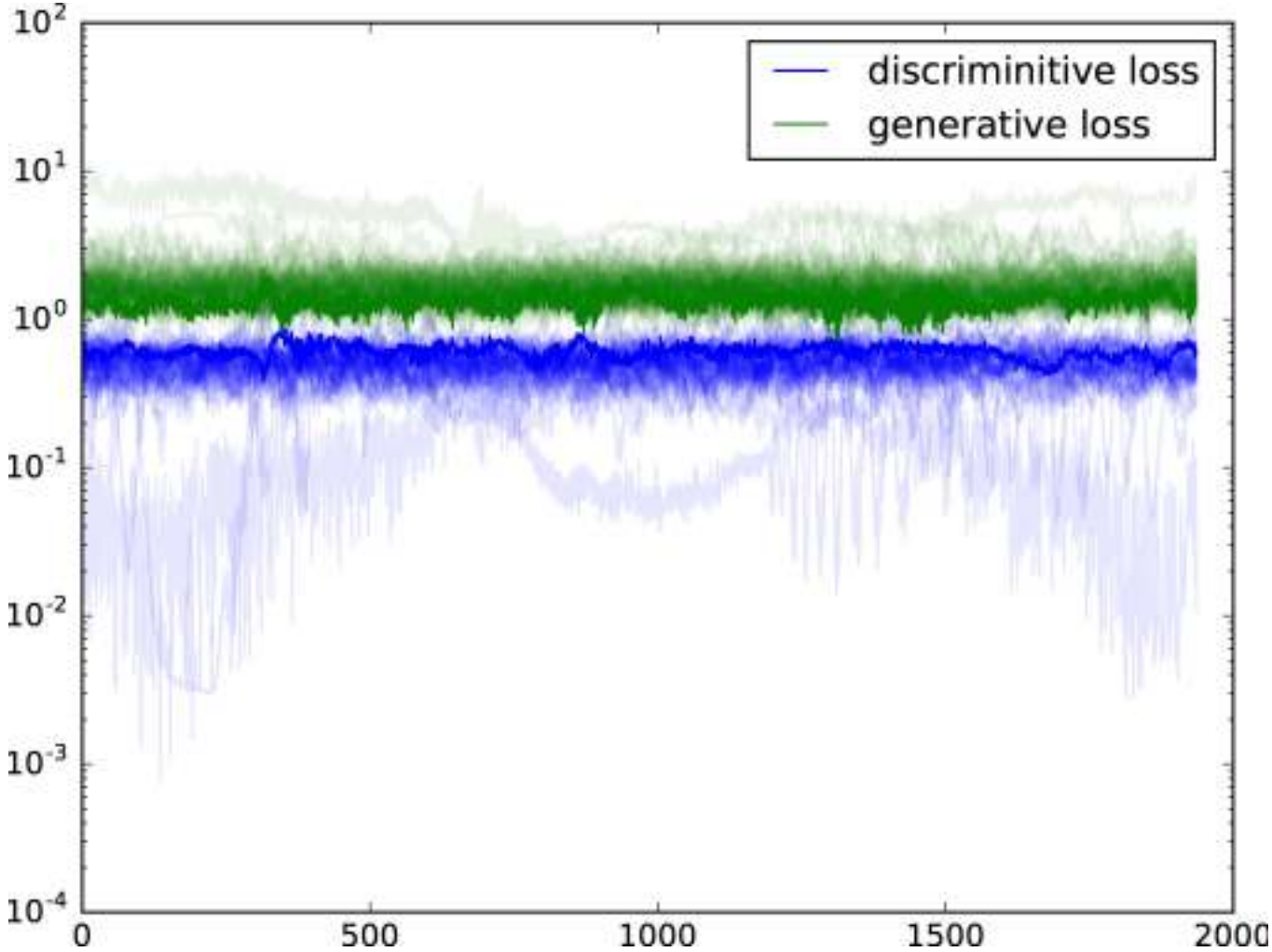
Training



Loss function training

- Minimise discriminator loss

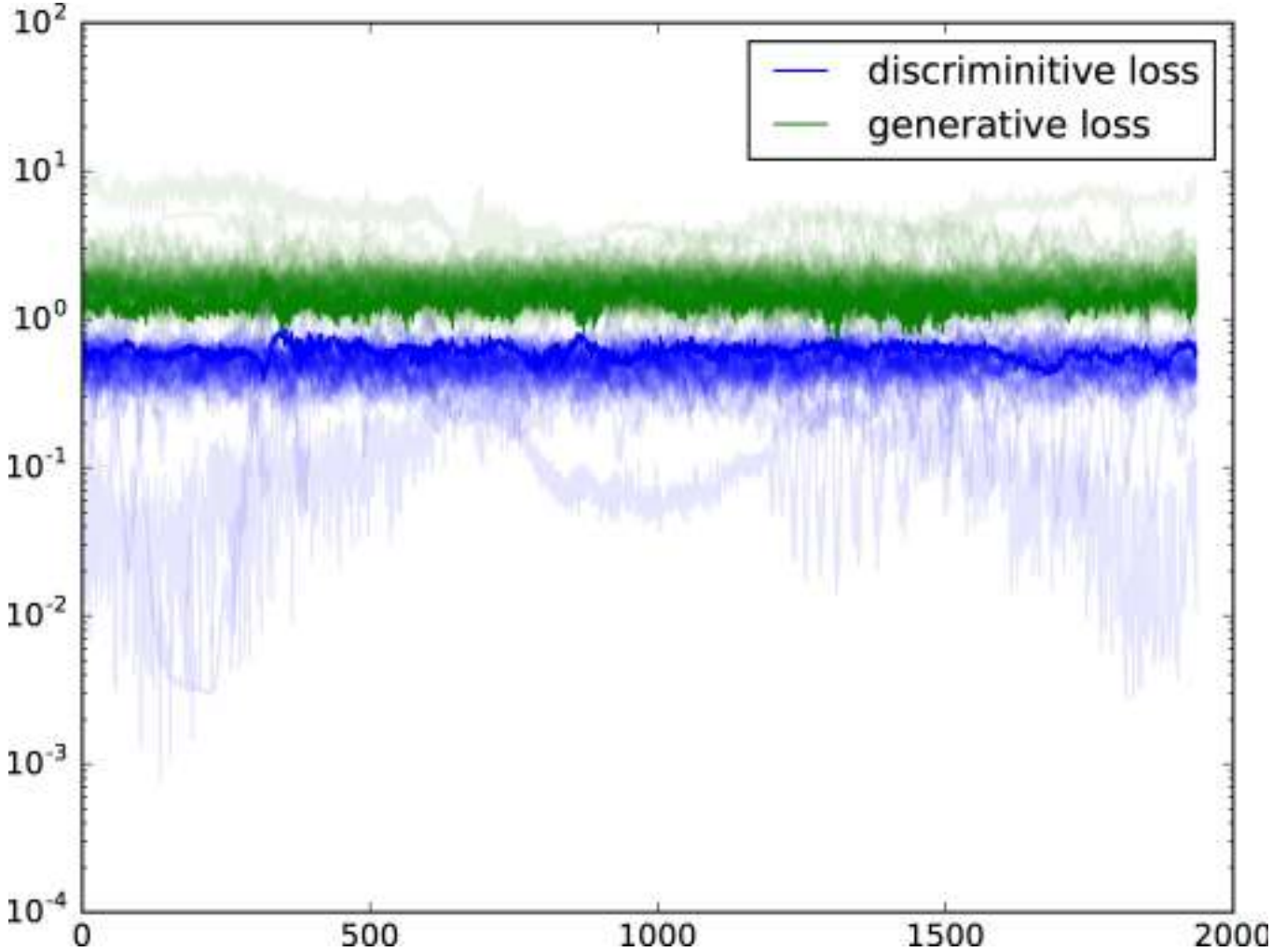
Training



Loss function training

- Minimise discriminator loss
- Minimise adversarial loss

Training

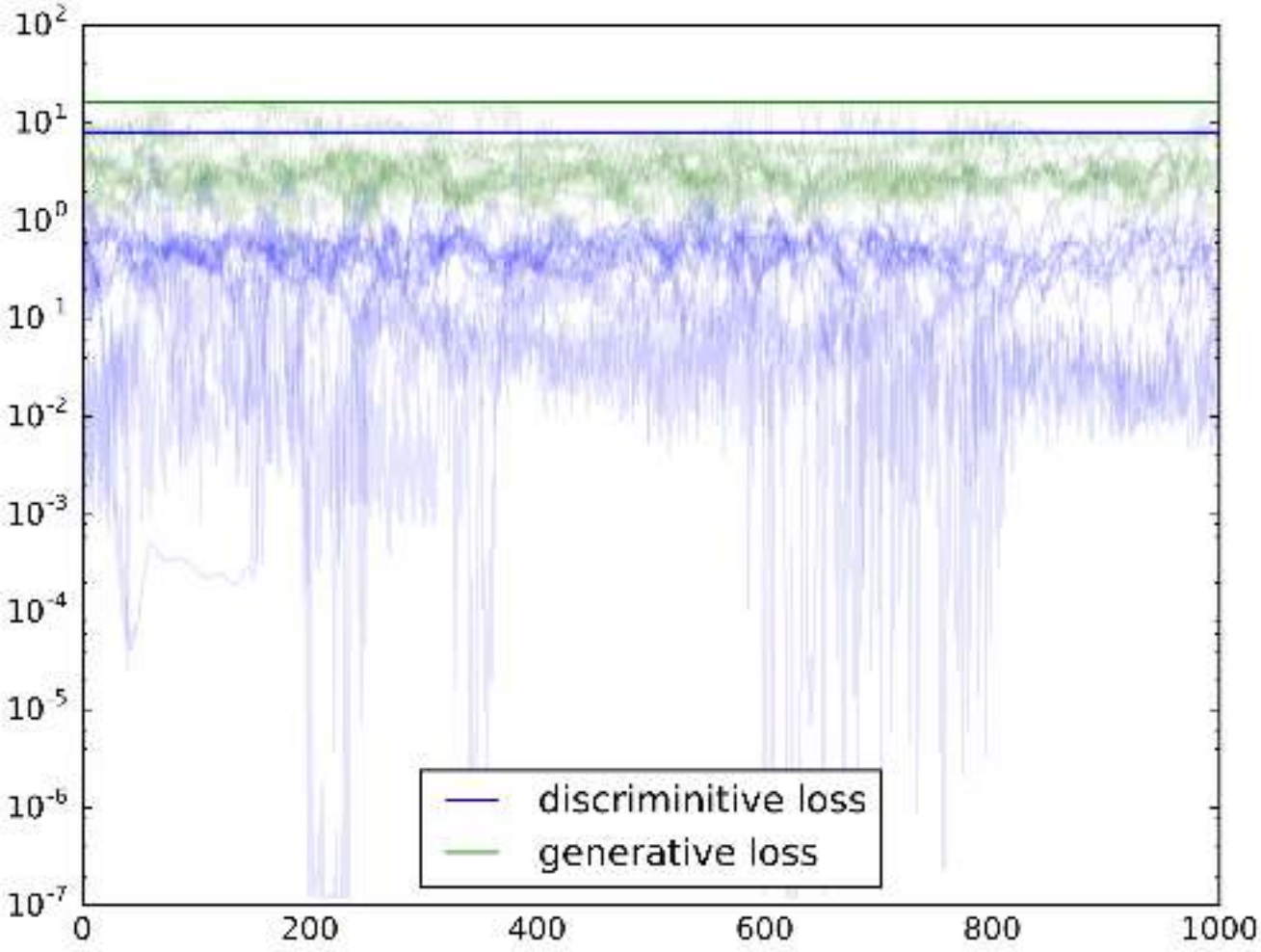


Loss function training

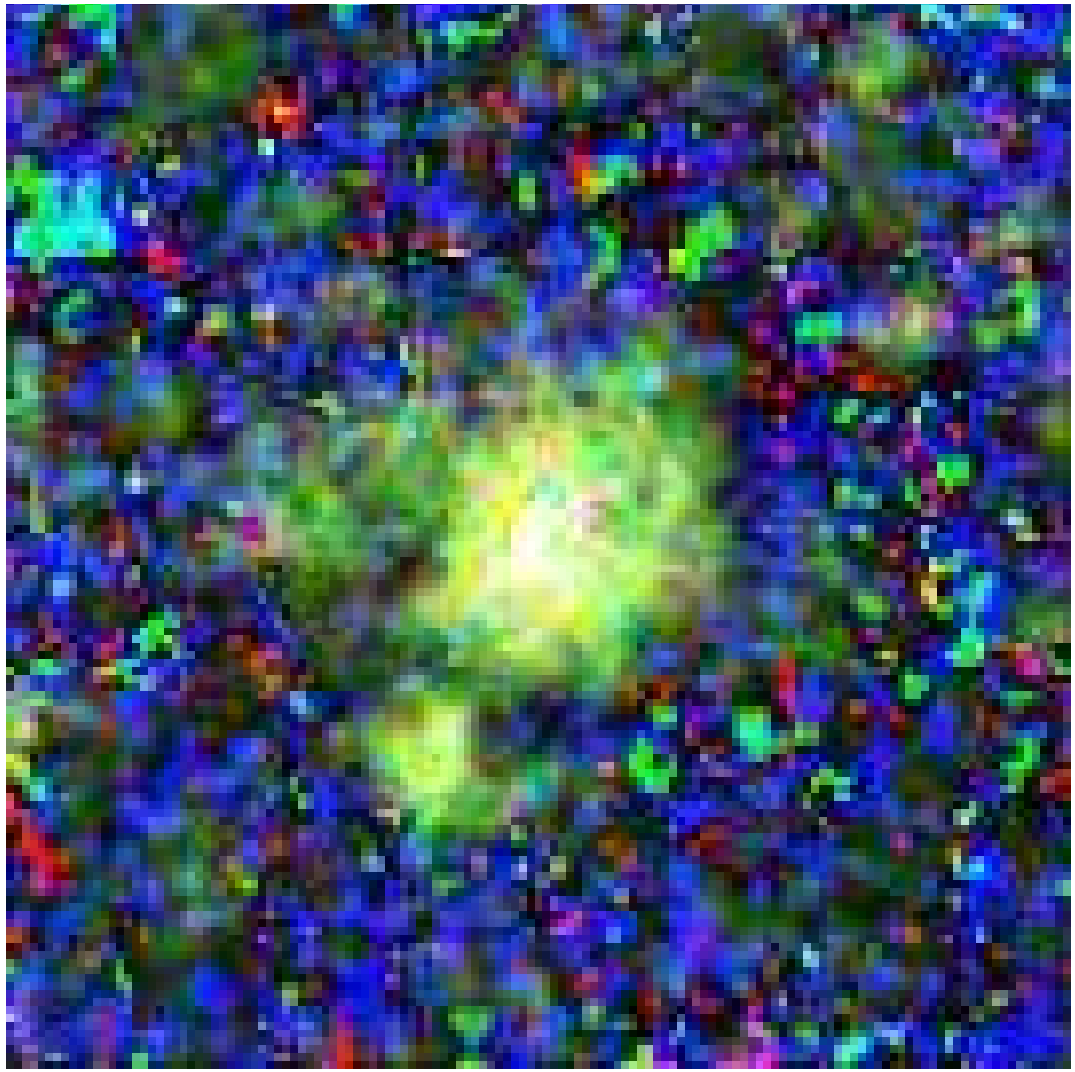
- Minimise discriminator loss
- Minimise adversarial loss
- Reaches stalemate

Generated galaxy

When training goes wrong



When training goes wrong



Galaxy classification using Inception