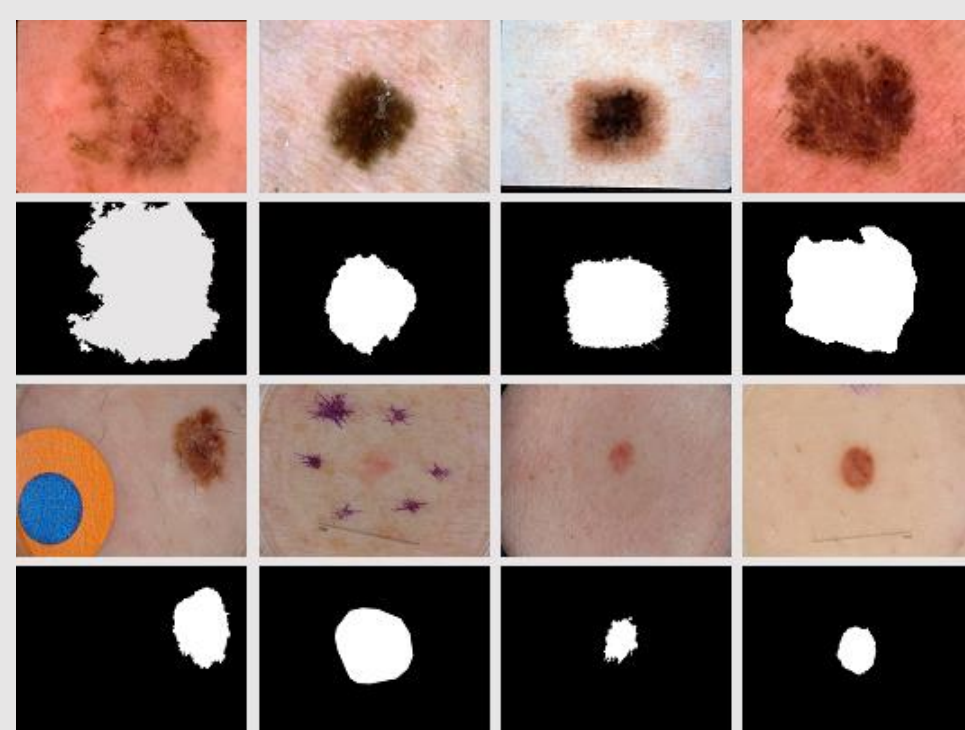


## Abstract

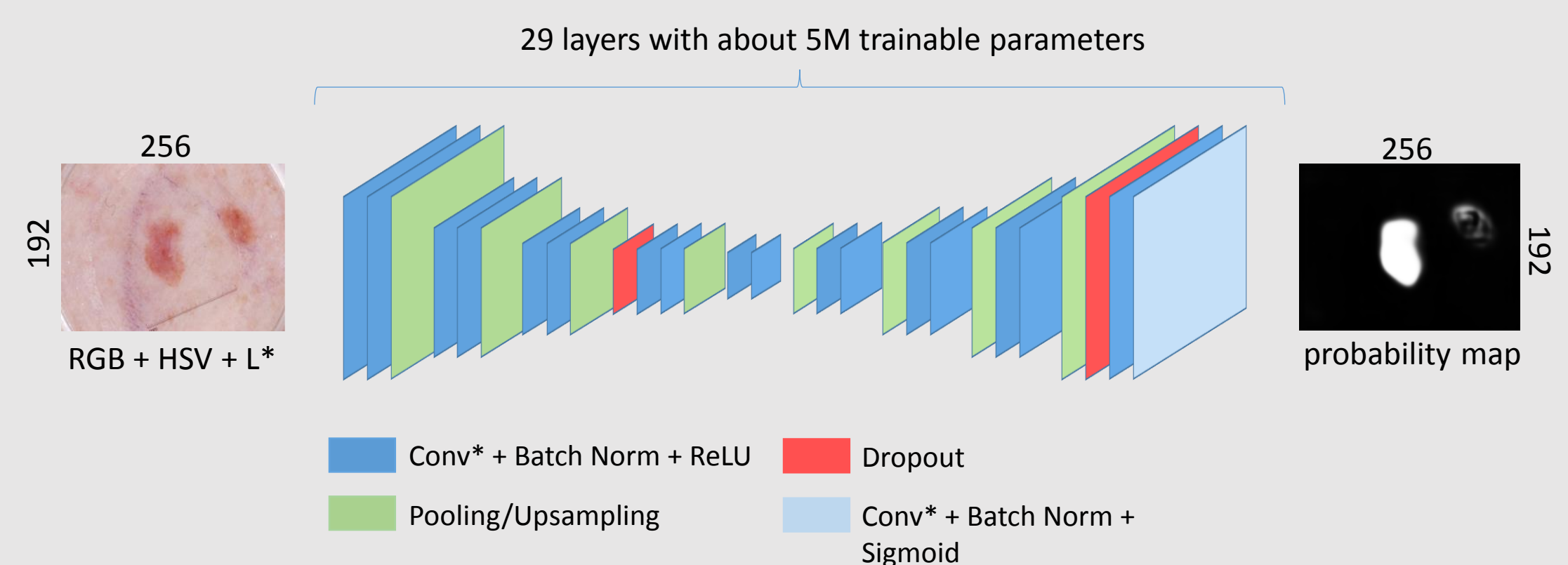
Malignant melanoma is the most dangerous skin cancer, with a substantial death rate. Automated skin lesion segmentation is a fundamental step to help experts in early diagnosis, but requires a huge amount of data to be performed. We present a Convolutional-Deconvolutional Neural Network (CDNN) to automatically generate the lesion segmentation mask from dermoscopic images, and propose a novel strategy to augment data, generating both skin lesion images and their segmentation masks.



Samples from the ISIC dataset.

## Baseline Architecture

Our model maps the input dermoscopic image into a posterior probability map, exploiting an architecture based on the CDNN which won the International Skin Imaging Collaboration (ISIC) challenge in 2017 [1].



\* fixed stride of 1 pixel.

[1] Yuan, Yading, Ming Chao, and Yeh-Chi Lo. "Automatic skin lesion segmentation with fully convolutional-deconvolutional networks." arXiv preprint arXiv:1703.05165 (2017).

## Hyperparameters Analysis

The baseline CDNN is mainly affected by three hyperparameters, which are stressed in our analysis:

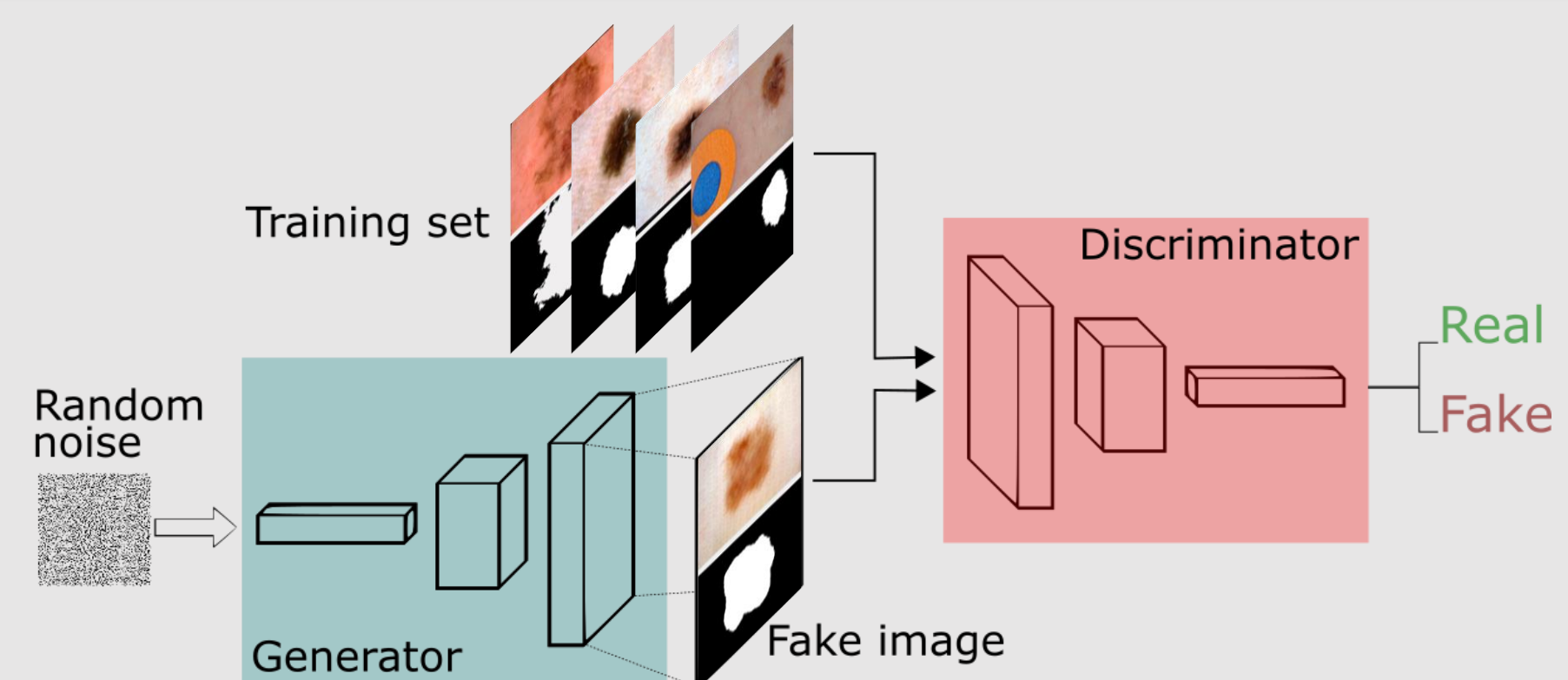
- 1) *Input image size:*
  - 96x128
  - 192x256
  - 384x512
- 2) *Image channels:*
  - RGB
  - RGB + HSV + L\*
  - RGB + HSV + CIELAB
- 3) *Loss function:*

$$L = 1 - \frac{\sum_{i,j} t_{ij} p_{ij}}{\sum_{i,j} t_{ij}^2 + \sum_{i,j} p_{ij}^2 - \sum_{i,j} t_{ij} p_{ij}} \quad (Eq. 1)$$

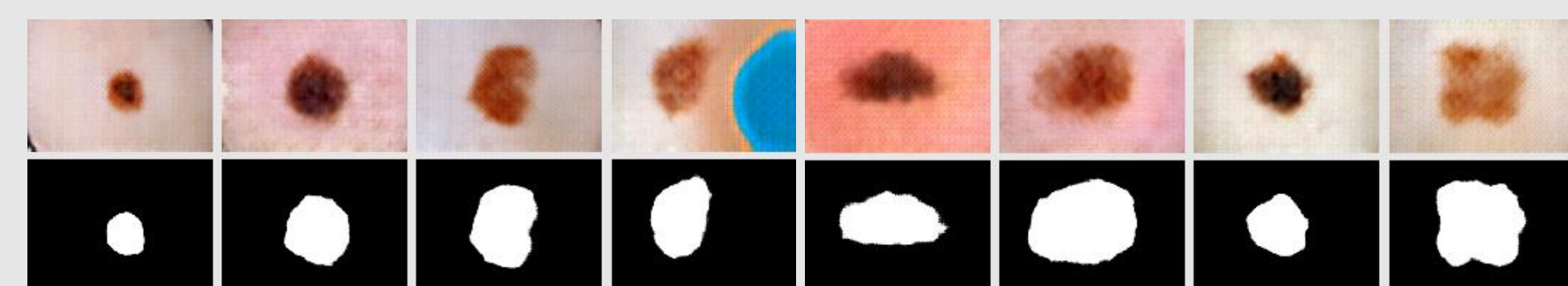
$$d_j = 1 - \frac{\sum_{i,j} t_{ij} p_{ij}}{\sum_{i,j} t_{ij} + \sum_{i,j} p_{ij} - \sum_{i,j} t_{ij} p_{ij}} \quad (Eq. 3)$$

$$L = \frac{1}{n} \sum_{i,j} (t_{ij} - p_{ij})^2 \quad (MSE)$$

## GAN Augmented Data



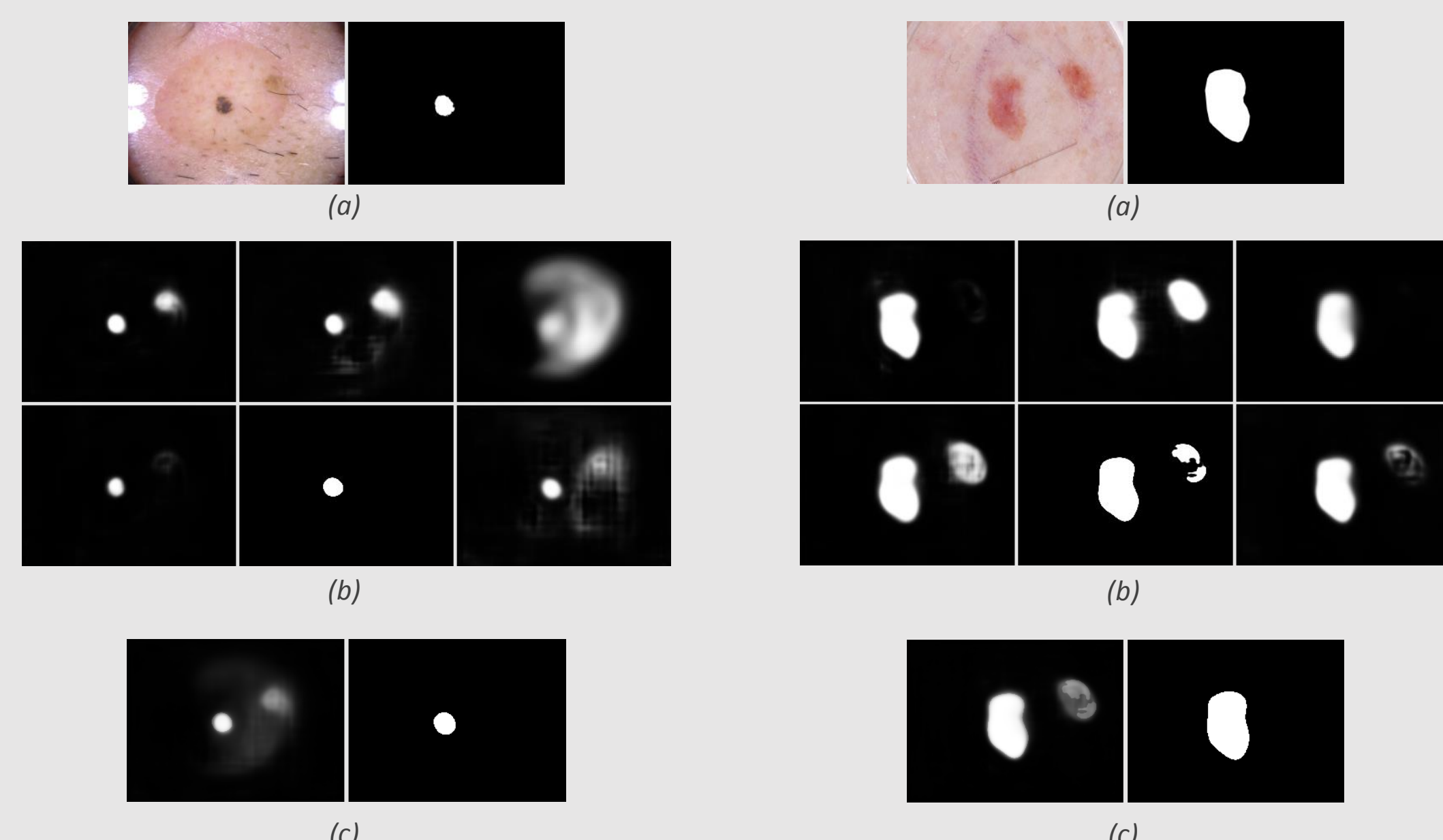
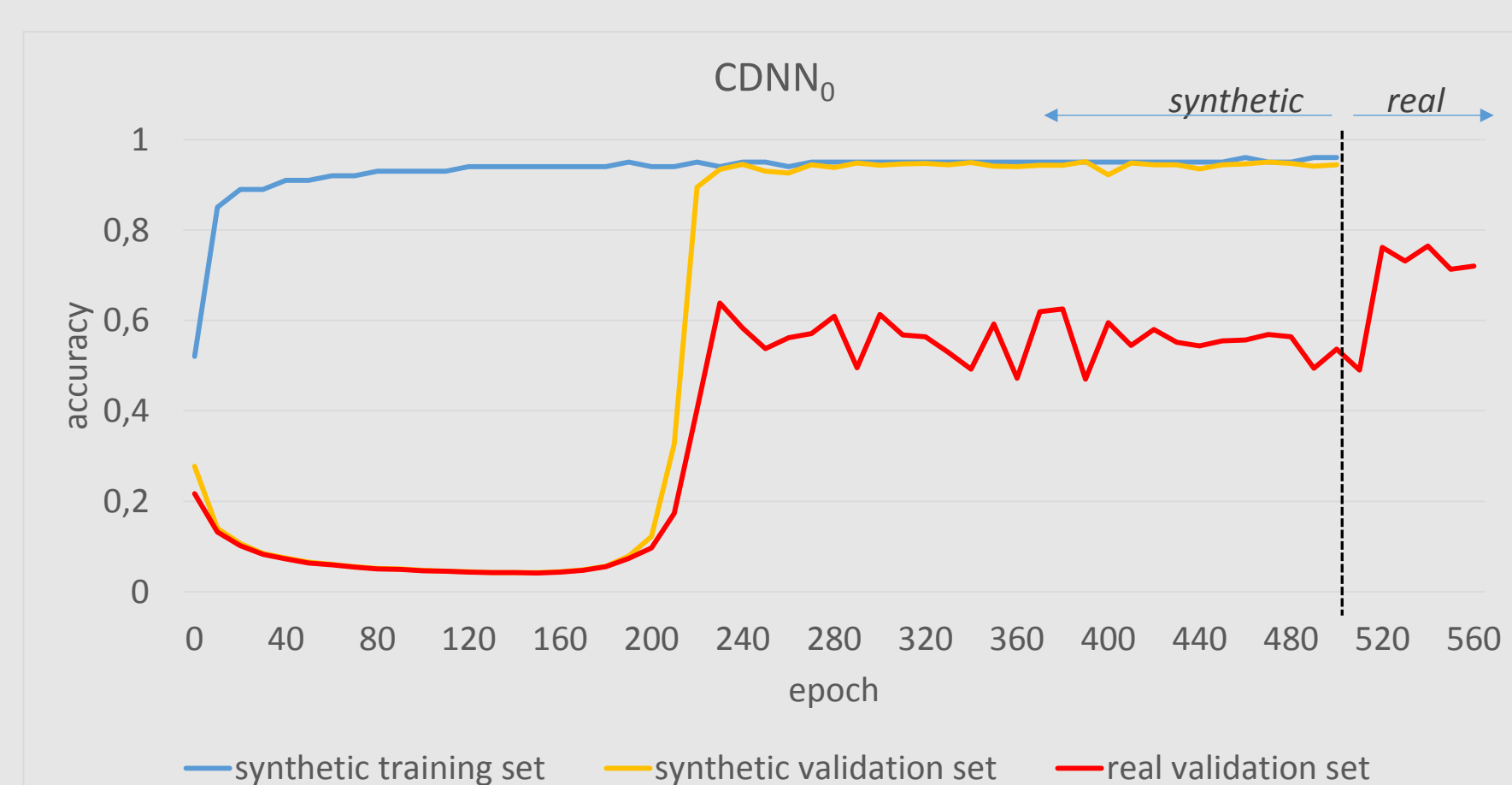
A DCGAN is employed to generate both the skin lesion image and its segmentation mask, improving the data augmentation process.



Samples from the generated dataset.

## Experimental Results

Neural Network	Input Size	Number of Channels	Loss Function	Without Augmentation	With Augmentation
CDNN <sub>0</sub>	192x256	7	Eq. 1	0.731	0.743
CDNN <sub>1</sub>	192x256	3	Eq. 1	0.732	0.753
CDNN <sub>2</sub>	192x256	9	Eq. 1	0.734	0.743
CDNN <sub>3</sub>	96x128	7	Eq. 1	0.735	0.750
CDNN <sub>4</sub>	384x512	7	Eq. 1	0.700	-
CDNN <sub>5</sub>	192x256	7	Eq.3	0.738	0.738
CDNN <sub>6</sub>	192x256	7	MSE	0.738	0.739
<b>Ensemble:</b>				<b>0.781</b>	



(a) Input image and ground truth. (b) Left-to-right then top-to-bottom, output prediction of CDNN<sub>1</sub>, CDNN<sub>2</sub>, CDNN<sub>3</sub>, CDNN<sub>0</sub>, CDNN<sub>5</sub> and CDNN<sub>6</sub>. (c) Outputs ensemble before and after binarization.