# Machine learning for prostate tumor delineation.

A hybrid GAN (Generative Adversarial Network) for prostate tumor delineation 🡪 machine learning technique used to automatically segment prostate tumors from medical images.

**GAN** is a type of neural network that consists of two parts: a generator and a discriminator.

* The generator is trained to generate new data that looks similar to the real data.
* The discriminator is trained to distinguish between real and generated data.

By training these two parts in an adversarial manner, the generator learns to produce realistic data that can be used for a variety of applications, such as image generation or segmentation.

In the case of prostate tumor delineation, a hybrid GAN is trained on a set of medical images that contain both normal prostate tissue and prostate tumors. The generator part of the GAN is trained to generate new images that contain only the tumor, while the discriminator part of the GAN is trained to distinguish between the generated images and real images. Once the GAN is trained, it can be used to automatically segment prostate tumors in new medical images. The GAN takes in an image as input and generates a mask that highlights the region of the image that contains the tumor.

The use of a hybrid GAN for prostate tumor delineation has several potential benefits, including:

* Improved accuracy and consistency of tumor segmentation.
* Reduced time and labor required for manual segmentation.
* Improved treatment planning and monitoring.

# Papers:

<https://arxiv.org/pdf/1702.08014.pdf>

Advantages of GANS:

* The advantages of adversarial training are that it does not introduce additional complexity to the model and requires no manual design of higher-order losses, resulting in very efficient model.

<https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8845397&casa_token=N7PzaslUHdQAAAAA:X1SGz1ARujPKzy9juXDTWGr3VWgxYfk74UUekOvgERGN3OY2Tz132iCaDdRpPr5GyPbj_AAvWQ&tag=1>

**U-net** and GANs:

* Use as the generator U-Net architecture with Dense layers.

Diagram, schematic

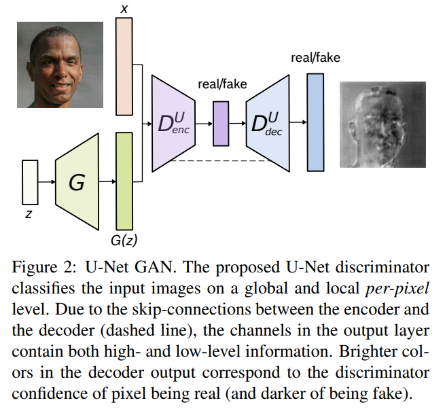
Description automatically generated

<https://openaccess.thecvf.com/content_CVPR_2020/papers/Schonfeld_A_U-Net_Based_Discriminator_for_Generative_Adversarial_Networks_CVPR_2020_paper.pdf>

* **U-net** Based Discriminator:

G and D are modeled as a decoder and an encoder convolutional network, respectively. In this paper: alter the D architecture from a standard classification network to an encoder-decoder network – U-Net, leaving the underlying basic architecture of D – the encoder part – untouched.

Advantage: U-net maintains both global and local data representation, providing more informative feedback to the generator.

Chart

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The discriminator now consists of the original down sampling network and a new up sampling network. The two modules are connected via a bottleneck, as well as skip-connections that copy and concatenate feature maps from the encoder and the decoder modules.

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* Regularization by mixing or/and cutting samples from different classes. GitHub!!!
* We build upon the recent state-of-the-art **BigGAN** model. But change the discriminator to be the U-Net GitHub!!!

Diagram

Description automatically generated

<https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9446143>

* Adversarial U-Net
  + D undergoes standard CNN supervised training, and for each image input, it outputs the probability of the image being produced by G with the goal of minimizing its error rate of classifying ‘fakes’ as real data set images.
  + The generator G produces images that are periodically fed to the discriminator.

Text

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A picture containing text, clock

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* Loss function: cross-entropy loss (the other standard loss function in image segmentation is the Dice loss, Intersection over union or Tversky loss)

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* Evaluation metric: accuracy, precision, specificity, recall, sensitivity, FScore.

<http://www.joig.org/uploadfile/2018/1226/20181226015625255.pdf>

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Table

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* Modified U-Net, Modified U-Net + GAN, Modified U-Net + WGAN.
* Evaluation metrics: Dice, precision, recall.

<https://arxiv.org/pdf/1512.09300.pdf>

GITHUB code: <https://github.com/rishabhd786/VAE-GAN-PYTORCH>

* VAE-GAN

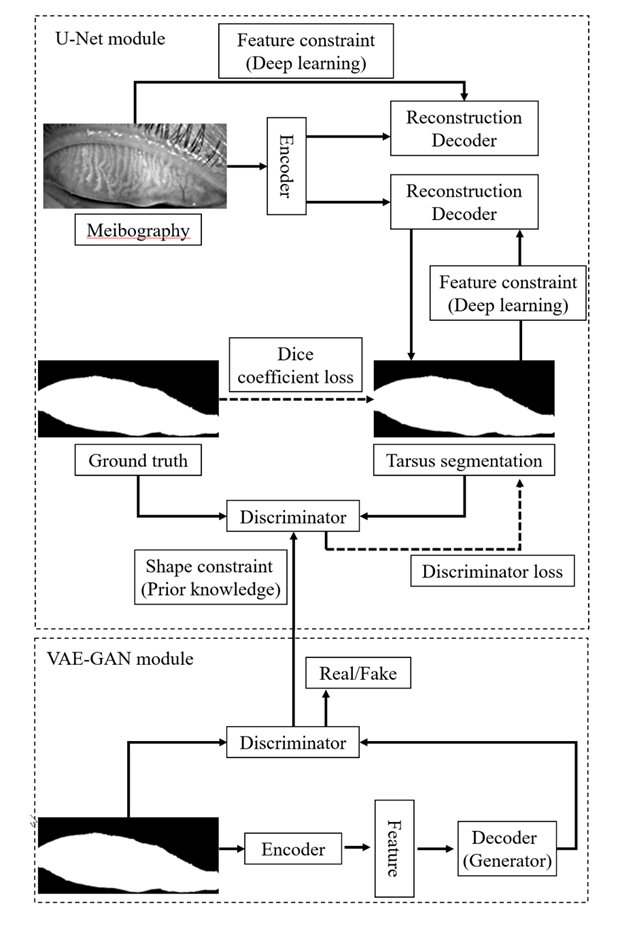
Diagram

Description automatically generated

<https://www.researchgate.net/publication/367534710_A_Deep_Learning_Model_for_Evaluating_Meibomian_Glands_Morphology_from_Meibography>

Text

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# Machine learning Plan.

* Generate data using a modified U-Net.
* Discriminate between fake and real using a discriminator. Update weights to get better and better results.