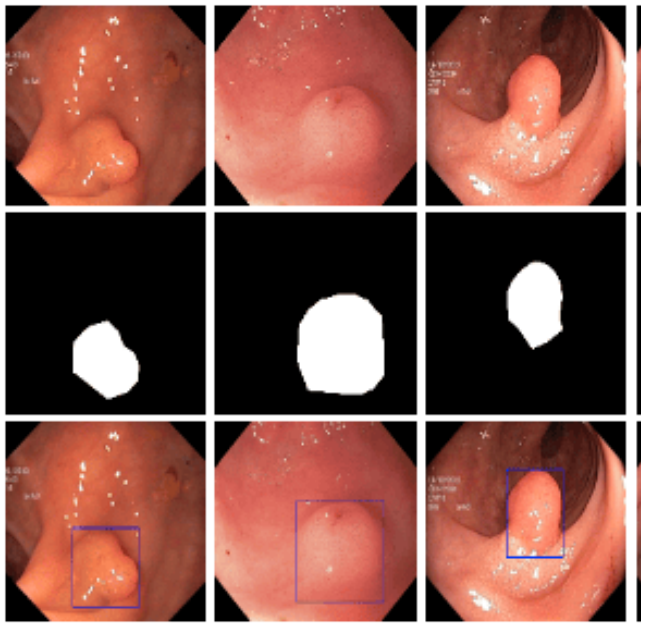
Polyp Segmentation

by Tim Kong



Polyps

Polyps are abnormal tissue growths that form on the lining of the colon. While generally benign, some types can develop into cancer.

Problem Statement

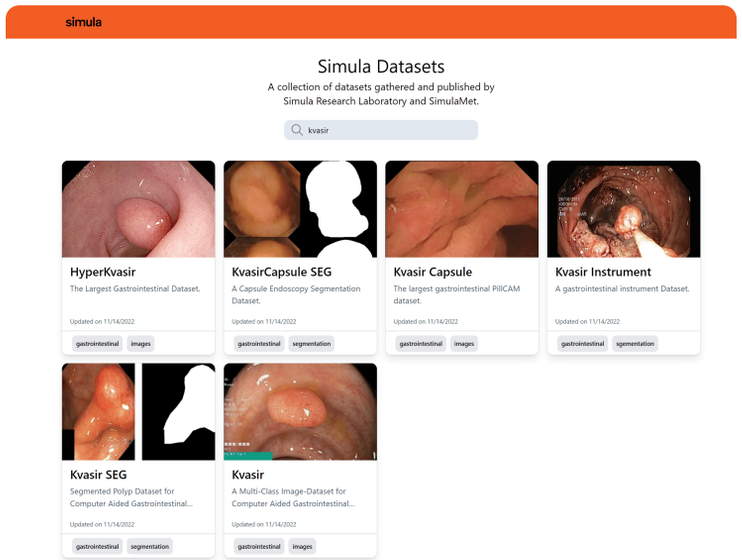
The challenge in healthcare is the early and accurate detection of these polyps to prevent the onset of cancer.

Proposal

Polyp Segmentation combines computer vision and machine learning techniques to identify and outline the boundaries of polyps, assisting healthcare professionals in early diagnosis and treatment planning.

Data Collection

Data Source



A collection of datasets gathered and published by Simula Research Laboratory and SimulaMet.

The Kvasir-SEG dataset was presented at the 26th International Conference on MultiMedia Modeling (MMM 2020).

Data Description

Data points	1000 polyp images and corresponding ground truth masks, manually labelled by a medical doctor and verified by experienced gastroenterologist.
Resolution	Varies from 332x487 to 1920x1072 pixels.
Features	Each feature corresponds to a pixel in the images that contains information such as color intensity, texture, spatial location, and many more.
Target	Predict the target segmentation map based on the input features.

Data Preparation

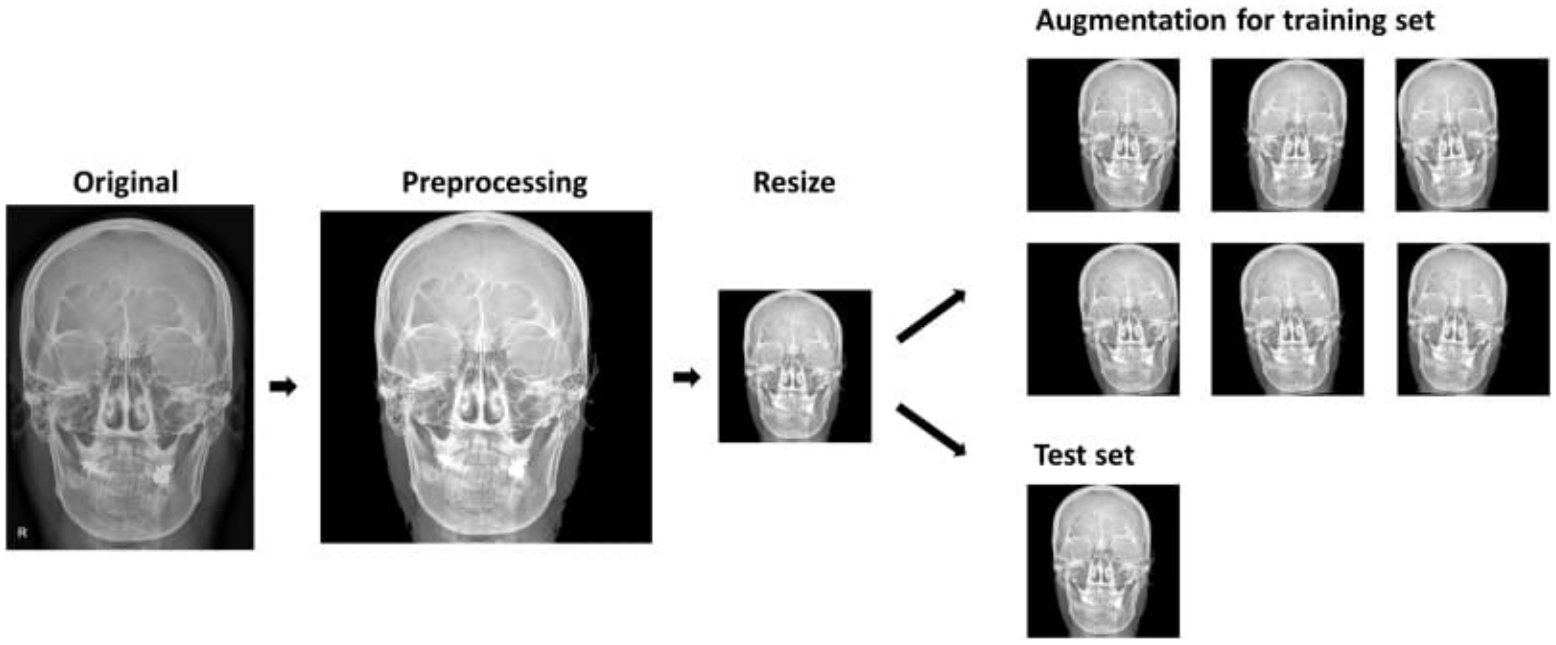


*Image courtesy of eBioMedicine, The Lancet. Retrieved from **URL***

Preprocessing: Rescaling

The factor of 1/255 is used for rescaling the images because the pixels in a standard 8-bit image range from 0 to 255. By dividing each pixel value by 255, the data is normalized to a range between 0 and 1.

Resizing

The images and masks are resized to a target dimension of 256×256 pixels to maintain a consistent input size for the model.

Augmentation

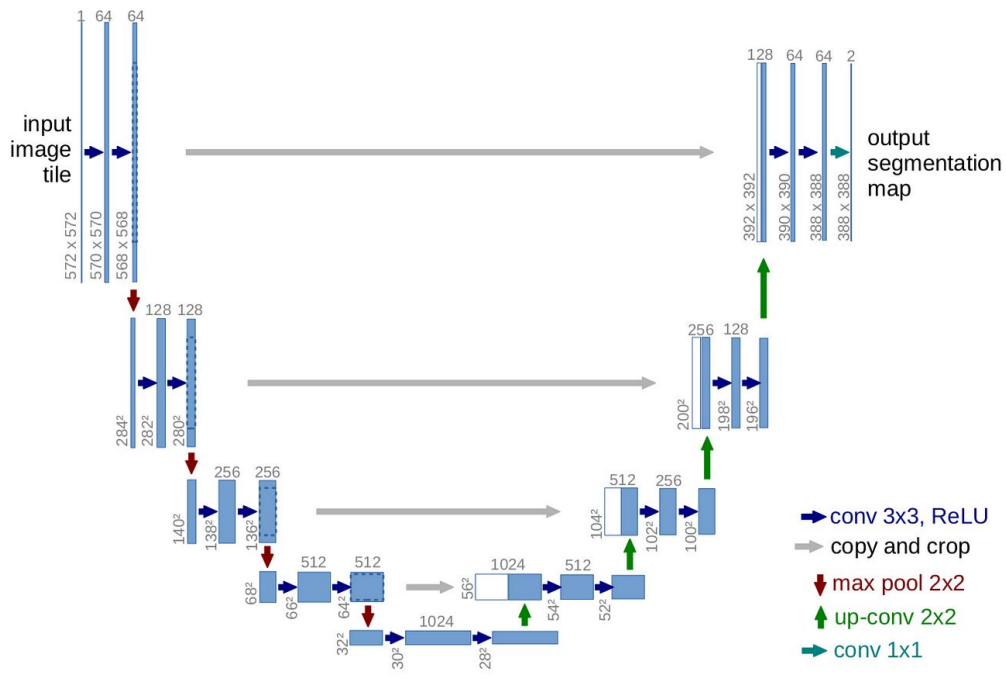
Augmentation techniques such as:

- horizontal and vertical flipping
- rotation
- zooming
- brightness adjustments, and more

are employed to enhance the model's ability to generalize across various conditions and orientations of polyps.

Modeling

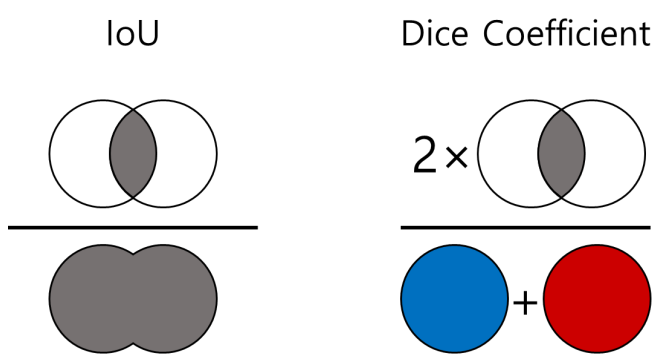
1 Model: U-Net



- U-Net was presented at the Medical Image Computing and Computer-Assisted Intervention (MICCAI 2015) conference, event focuses on the development and application of advanced computational methods for medical imaging.
- Since its introduction, the U-Net has become a go-to architecture for image segmentation problems, inspiring numerous variations and adaptations.
- U-Net was initially designed for tackling biomedical image segmentation problem, but later on has been widely adopted for a variety tasks beyond biomedical imaging, including satellite image analysis, object detection in photos, and much more.

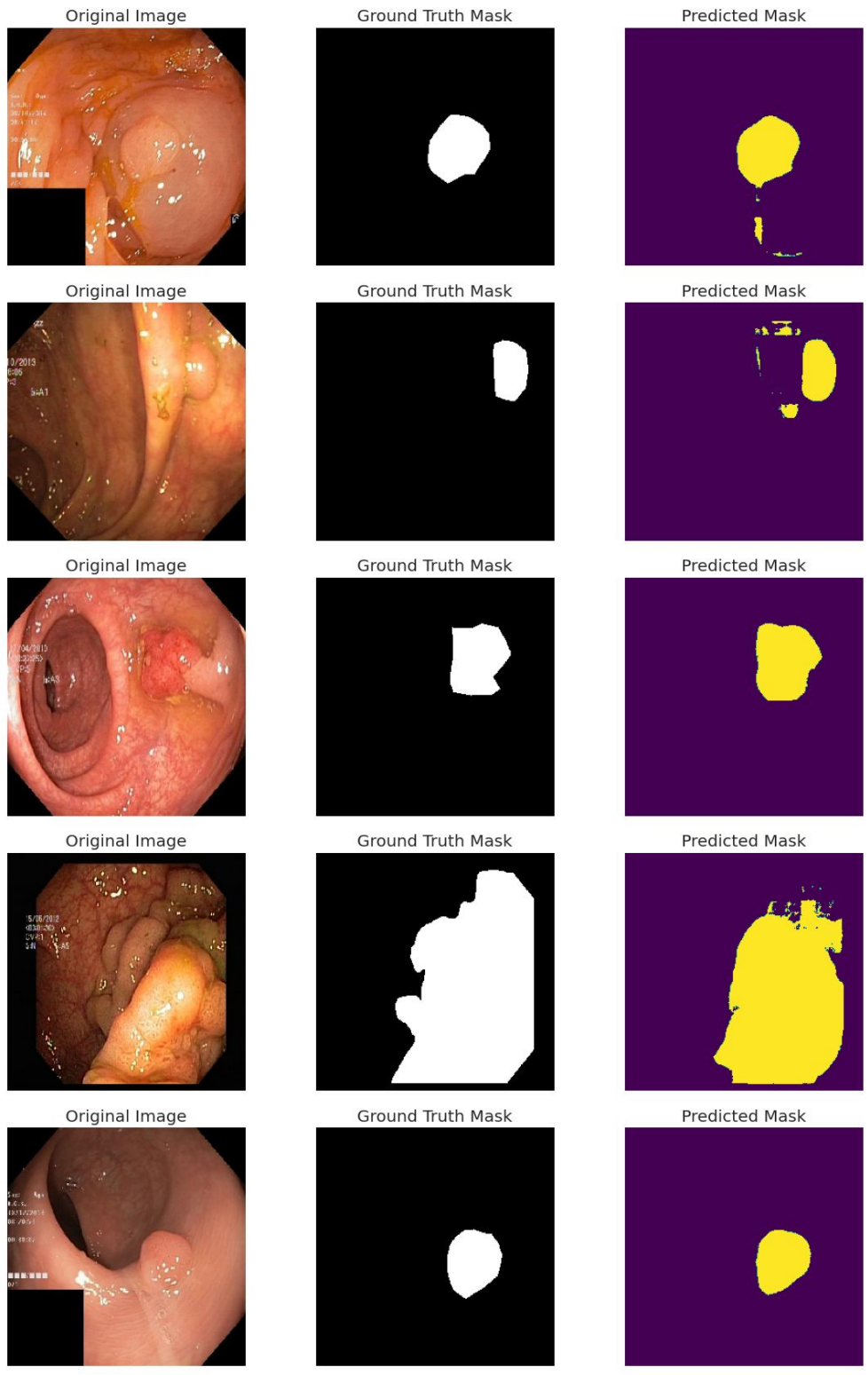
2 Model Training

3 Model Evaluation: IoU and Dice Coefficient



- IoU (Intersection Over Union) = 0.738
- Dice Coefficient = 0.857

4 Model Prediction



Future Development

Areas of Improvement

- **False Positives**
  The presence of spurious detections indicates room for improvement in precision.
- **Boundary Outline**
  The model could be improved in terms of its spatial accuracy, particularly at the boundaries of the target region.

Recommendations

- **Threshold Tuning**
  Fine-tune the prediction threshold to balance false positives and false negatives.
- **Data Augmentation**
  Use more diverse training data or apply techniques like ***boundary jitter*** to make the model more robust to boundary variations.
- **Current state of art model: Meta-Polyp**
  The current state-of-the-art model on Kvasir-SEG is ***Meta-Polyp***, which is a recent development as of 2023. The model outperforms standard UNet architectures, especially on challenging aspects like missing boundaries and small polyps.