info@apriorit.com
www.apriorit.com

Case study

Building an AI-based Healthcare Solution

A US-based healthcare center asked us to develop a robust AI-based system that could track ovarian follicles across video frames, detect them in ultrasound images, and measure them.

Our team developed an efficient and complex solution that employs artificial intelligence (AI) algorithms. The delivered system has shown astonishing accuracy and helped our client accelerate and simplify their doctors' routine as well as provide high-quality services to their patients.

The client

Our client is a US-based healthcare institution that provides infertility testing and treatment services. Their doctors need to make accurate diagnoses and help families reduce the time from treatment to pregnancy.

The challenge

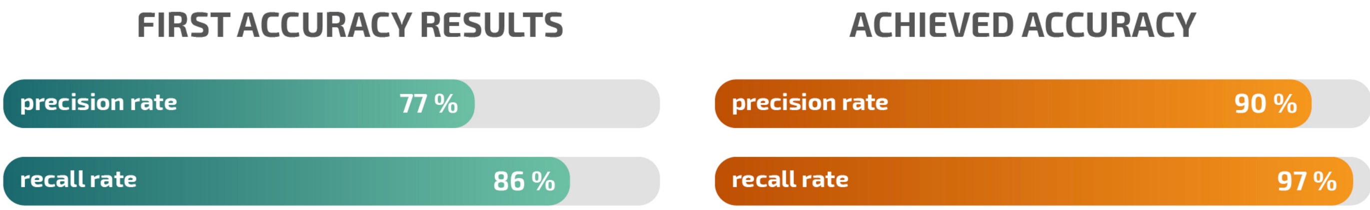
Therapists at the client's organization had to constantly pause ultrasound videos to detect and mark maximum horizontal and vertical diameters of follicles. Later, they had to manually measure the detected follicles. This was an extremely time-consuming process.

The client's challenge was to automatically detect, segment, and measure follicles in ultrasound images.

To solve this challenge, our client valued detection accuracy over speed. It was essential to achieve accurate results and detect as many follicles as possible.

The result

We successfully developed an AI-based healthcare system that processes ultrasound videos, detects follicles, and measures their diameter, surface area, and perimeters.



During the discovery phase, we explored possible approaches to and pitfalls of creating an AI solution for the specified purposes. Based on the results of our research, we decided we would strive for an initial accuracy of greater than 70%.

Our first result showed 77% precision and an 86% recall rate. With further research, development, and system training, we managed to increase the solution's efficiency up to 90% precision and a 97% recall rate.

Our approach

Before building a system for follicle detection, segmentation, and measurement, Apriorit gathered a team of professionals and carefully chose a set of technologies.

Apriorit Team	Project manager and AI developers
Software libraries	TensorFlow, Keras, OpenCV, NumPy, SciPy image processing modules - PIL, SciImage
Programming languages	python, GNU Octave

Since building an AI-based healthcare solution requires thorough preparation, we started with researching the nuances of the client's challenges. We needed to understand how doctors work with data on follicles and interpret ultrasound images before automating the detection and measurement of follicles.

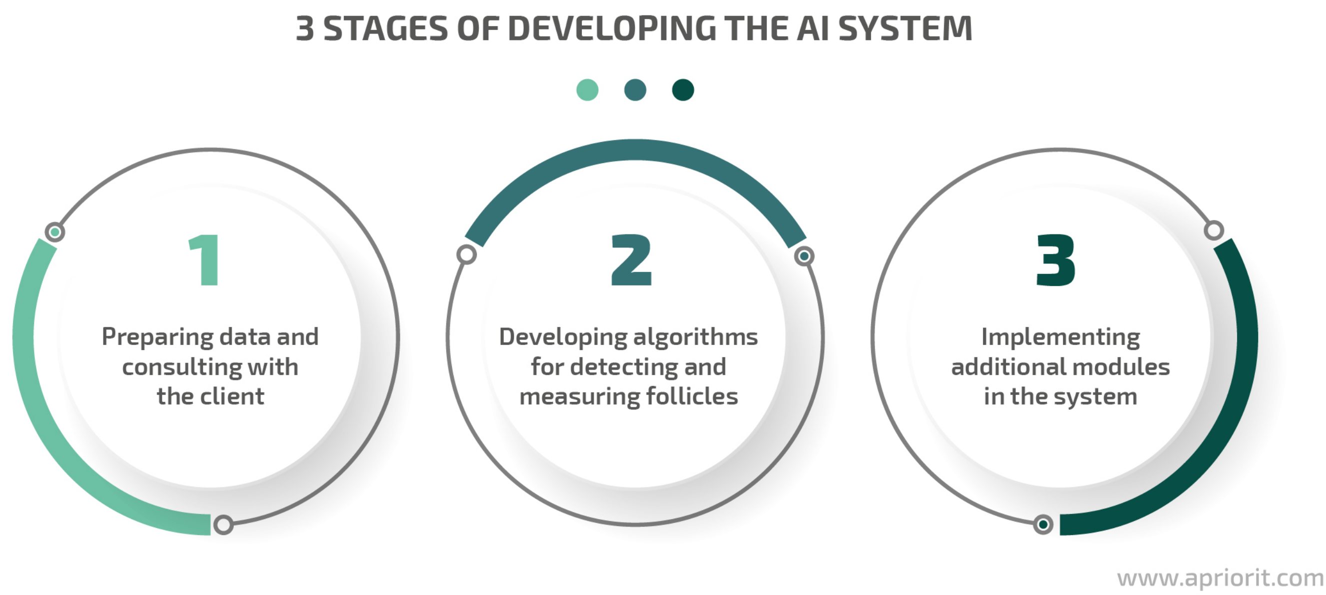
Once we received all the required information from our client, we planned the further development process, paying attention to possible pitfalls. Then, our team moved on to designing and developing the concept for the future system.

We developed a complex system that includes:

1. A neural network for follicle detection.
2. Pre- and post-processing modules that use hand-crafted machine learning and computer vision algorithms for follicle segmentation and measurement.
3. A post-processing module that generates reports with analytics and statistics on system precision, recall, etc.

How we did it

The project consisted of three main stages:



1. Preparing data and consulting with the client

There were several challenges we needed to handle before actually starting work on the solution concept. The most essential step was preparing data.

First, we had to focus on **creating a high-quality dataset** since the client only had raw data. We explained the importance of data quality to the client and provided them with full guidance regarding how to create a proper dataset.

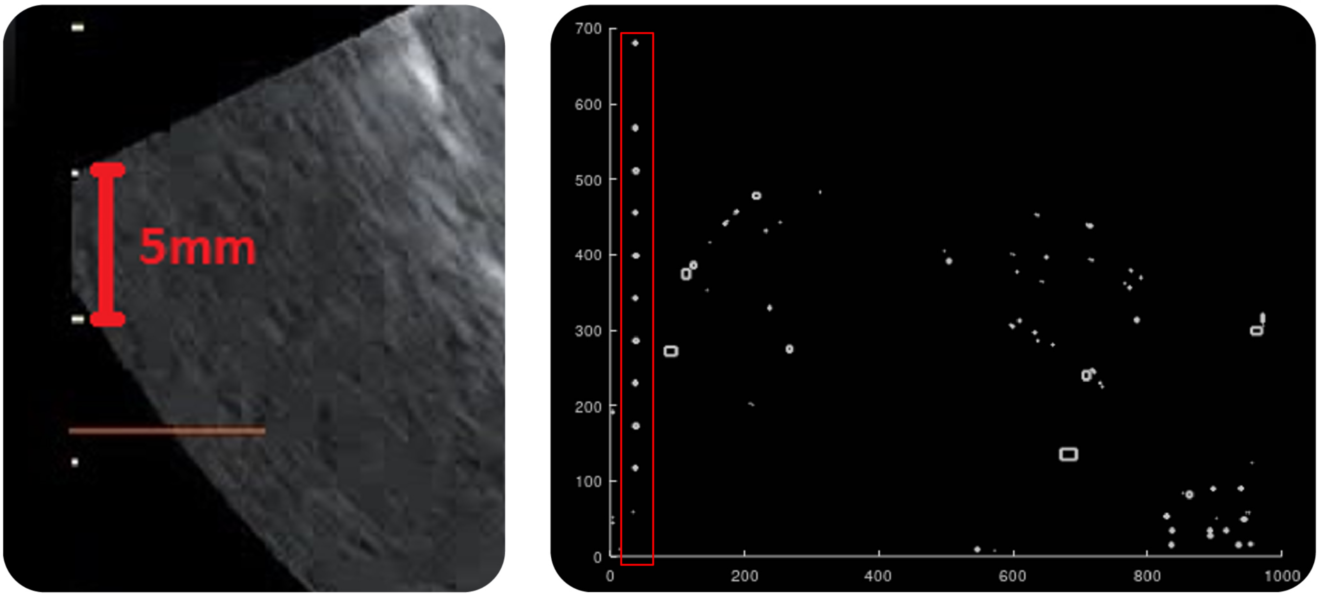
A dataset is a set of pairs — in our case, ultrasound images with annotations for each image, where the annotations contain the information we need to detect with our AI system. Datasets are used to train neural networks and check the accuracy of their results. So to train our client's system properly, we needed high-quality and consistent images with accurate annotations.

Since our clients' therapists have expertise in analyzing ultrasound images, our client was able to create a perfect dataset.

Once the initial dataset was ready, we started development of the AI system for healthcare.

Second, we needed to define the way the solution would measure objects in ultrasound images. Doctors manually measure physical parameters such as the diameter and perimeter of follicles. But AI algorithms can't do this properly, since they process image pixels. Therefore, we needed to know the size of one pixel in an ultrasound image.

Our client informed us that every ultrasound image has hatch marks on one side with a distance of 5 millimeters between hatches.



Investigating data and calculating object sizes

2. Developing algorithms for detecting and measuring follicles

The next step was creating the part of the solution to detect follicles. In the AI industry, detecting objects in images is called instance segmentation.

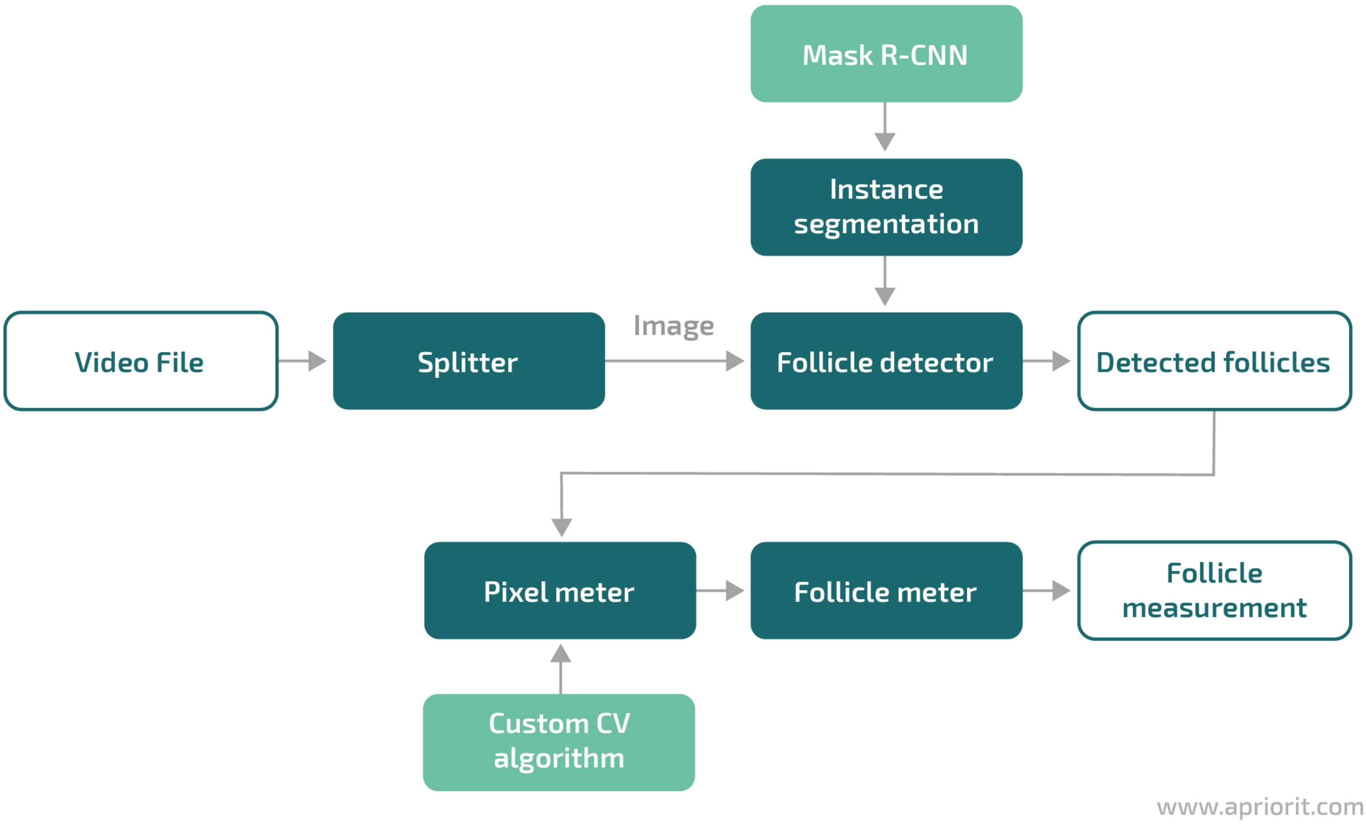
During thorough research, we explored the best instance segmentation solutions available and found that the most relevant architecture for our task was a region-based convolutional neural network with a residual network backbone called Mask R-CNN. We developed additional layers on top of Mask R-CNN to perform tracking and measurements on all detected follicles.

Then, we implemented an **image filtering algorithm to measure objects**. It helped us detect the hatch marks and calculate the number of pixels between them. Knowing the size of one pixel allowed us to calculate the size of any object in an image.

3. Implementing additional modules in the system

We **added several more helpful modules** to provide our client with the opportunity to work with different types of data. With these modules, therapists can detect follicles in separate images, folders with images, and videos in various formats. Our additional goal was to create a user-friendly interface.

The full concept of our AI-based system is shown in the image below:



The final concept of an AI system for detecting and measuring ovarian follicles

We marked the input to our system as "Video file" and the output as "Detected and measured follicles." In their traditional workflow, doctors receive data in the form of an ultrasound video and then pause it to mark follicles in images. We automated this process by using a module to automatically split a video into images. Then, we simplified the final concept of a system: one application detects follicles and another measures them.

Challenges and solutions

During the discovery phase, we highlighted a few challenges that needed to be solved before starting system development:

Matching pixels with object sizes — We couldn't build object measurement functionality without knowing the size of one pixel in an ultrasound image.

During a consultation with the client, we learned there are hatch marks in all ultrasound images spaced 5 millimeters apart. We found a way to detect these hatch marks and accurately calculate the pixel size prior to creating algorithms for follicle measurement.

Researching and preparing specific data — We needed to know how and where follicles are located in images. Also, we required a high-quality dataset containing information that we lack the qualifications to supply. Building an efficient solution was impossible without this dataset.

To acquire all the data we needed and gain an in-depth understanding of how doctors work with this data, we had extensive consultations with the client. Then, we summarized requirements for annotating data and our client used these requirements to prepare a high-quality dataset.

Lack of environment — Another challenge was testing our neural network's performance without an environment either we or our client had set up.

We solved this issue by using Google Colaboratory to increase hardware resources and successfully perform object recognition tasks. Later, we also set up an Azure deep learning environment to handle object recognition tasks.

The impact

With impressive results — 90% precision and a 97% recall rate — the delivered solution significantly helped our client with detecting and measuring follicles. The system saves doctors' time by eliminating the need to spend lots of time manually examining dozens of images. Thus, doctors can analyze video files quickly, re-check the system's results, and pay more attention to patients.

Our client is currently testing the system in their own fertility treatment center. They are also going to test our solution in more clinics once it's approved by the United States Food and Drug Administration (FDA). To help them with this process, the Apriorit team is documenting all the technical details required for submission to the FDA.

Ready to enhance your product with artificial intelligence? Entrust your project to the Apriorit team and enjoy the professional results!