Modeling a Patient's Heart with Artificial Intelligence

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With FiberNet, the researchers can learn the fibers of the heart of a specific patient, to then design and test medical interventions virtually.

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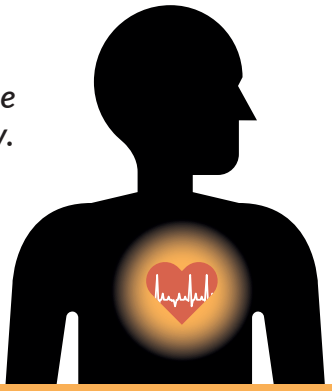
Cardiovascular diseases are the leading cause of death globally.

+ 17 million

deaths per year.



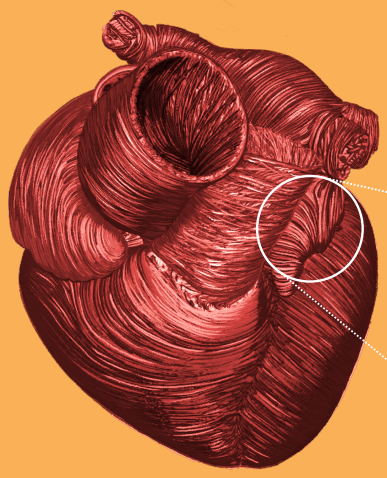
Atrial Fibrillation, a Common Pathology

It is a type of cardiac arrhythmia, which means that the electrical impulses of the heart do not function properly and generate irregular heartbeats.

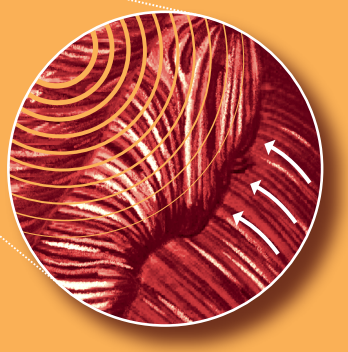
It is associated with other more severe heart diseases, which is why it must be treated on time.

The difficulty of studying the heart while is beating

This is one of the main obstacles to address heart diseases.
The existing exams do not provide information about all its characteristics, such as the orientation of the fibers.

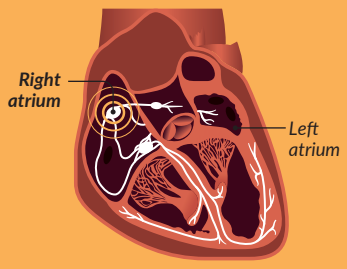


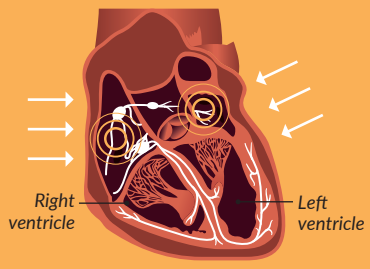
The orientation of the fibers plays a significant role on how the heart performs and its arrhythmias.

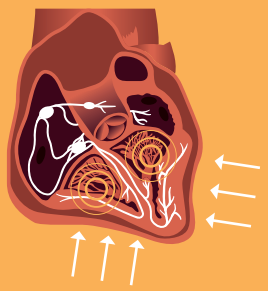


How the Heart Works

A heartbeat is driven by an electrical signal transmitted through the fibers.







Electrical waves travel at different speeds depending on whether they are aligned or not with the fibers.

1. Electrical waves are originated in the right atrium.
2. They are propagated through both atria, which send blood to the ventricles.
3. The ventricles contract and pump blood into the rest of the body.

Researchers are working on a method to obtain the fiber orientation of the heart.

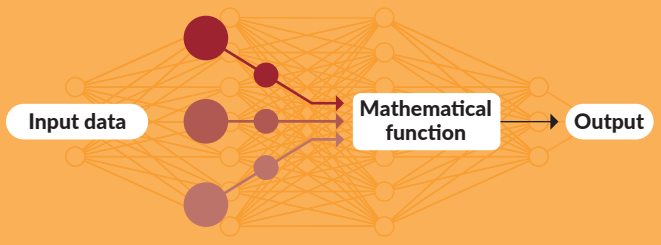
FiberNet: A Method to Model Heart Fibers

The researchers created a method to estimate the architecture of the heart's fibers through artificial intelligence. They use information that can be measured from electrical waves in the atria, complementing it with general laws of physics regarding the propagation of waves.

Applying Artificial Intelligence

What is an Artificial Neural Network?

It is a machine learning method inspired by the functioning of the human brain: It can process and find relationships among a large amount of data.



But what happens when there is not enough data, which is often the case in cardiac interventions?

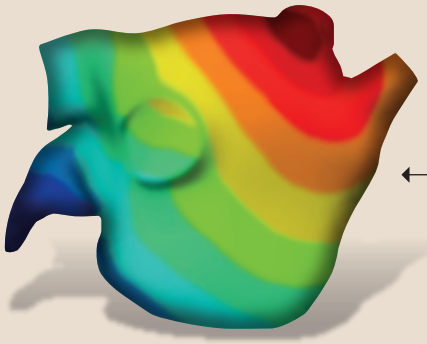
The researchers used a technique called PINNs (physics-informed neural networks).

Neural networks incorporate the laws of physics to compensate for the missing data.

That is how they can model complex problems.

How FiberNet Works

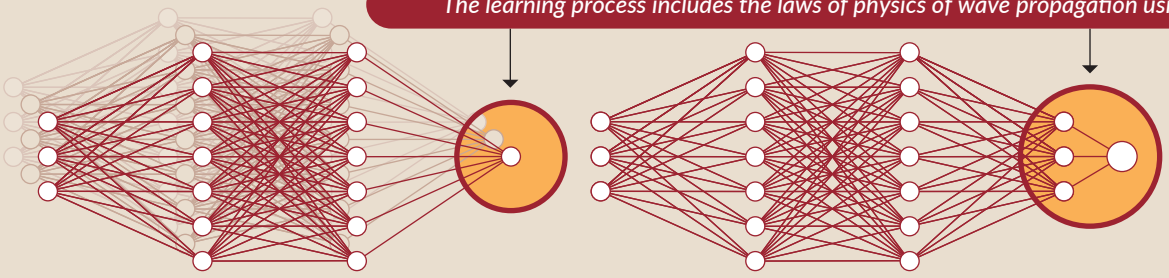
1 A catheter with an electrode that detects electrical waves is introduced in the atrium of the heart.



Cardiac activation maps are built with the collected data.

2 Training

The learning process includes the laws of physics of wave propagation using PINNs.

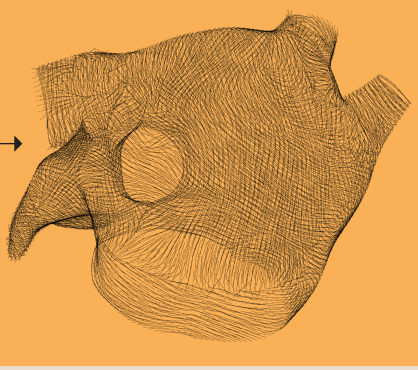


The activation maps are then represented as neural networks.

The orientation of the fibers (still to be specified) is also represented as a neural network.

3 The results obtained with this machine learning process allowed to accurately model the heart's fibers' orientation.

FiberNet was tested on simulated **2D** and **3D** models, in an explanted heart, and on a real patient.



One Step Towards Precision Medicine

This technology allows for a medical practice that is more personalized and offers more efficient treatments.

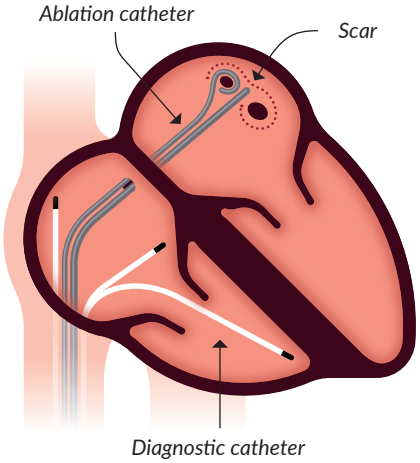
Testing Digitally Before Any Interventions

FiberNet allows testing cardiac medical interventions in personalized digital models before than in patients.

An Example: Ablation Treatment

Knowing exactly the orientation of the fibers allows to simulate several options for this treatment and predict how the heart would react to them.

Cardiac ablation is a procedure that uses small burns to cause some scarring in small areas of the heart to block irregular electrical signals.



- More information on the effectiveness of the treatment.
- More accurate interventions
- Better results
- Reduction of recurrences, thus repeating the treatment.

Future Challenges

1. Facilitate the use of **FiberNet** in clinical practice.
2. Apply FiberNet to the ventricles and other pathologies.
3. Create other innovative tools that contribute to narrowing the gap between science and clinical practice.

The Importance of Prevention

Our heart's health depends widely on our lifestyle. Keeping a balanced diet, exercising regularly, avoiding alcohol and tobacco, and managing stress help prevent heart disease.

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