ENABLING DOCTORS THROUGH AI

Deep learning for ECG analysis

Paris Sciences & Data

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CARDIOLOGS: ENABLING DOCTORS THROUGH AI

AI-AIDED DECISION MAKING HEALTH PROFESSIONALS MORE ACCURATE AND FASTER
A TYPICAL ECG
A TYPICAL ECG
ATRIAL FIBRILLATION: A SUBSTANTIAL PUBLIC HEALTH CHALLENGE

- **x6** Risk of stroke
- **200K** New cases diagnosed/y

AF IS DIAGNOSED BY UP TO 3-WEEK AMBULATORY CARDIAC MONITORING

2016 projections

- 6 M
- 9 M
- 17 M

+8 M new cases in the next 15 years

Source: Epidemiology of atrial fibrillation: European perspective, Zoni-Berisso et al., 2014
MACHINE LEARNING FOR AFIB DETECTION
WHY DEEP NEURAL NETWORKS

CORE TECHNOLOGY

State-of-the-art performances in...

- Image classification
- Object classification
- Speech recognition
- And more...

CARDIOLOGS TECHNOLOGY

First DNN architecture adapted to ECG data

Machine automatically learns from ECG data and annotations
DETECTION OF AF ON ECGs

- RR irregularity
- Absence of P wave
- Baseline oscillation

Normal Sinus → AFIB

Cardiologs
HOW DOES IT WORK?

Deep Neural Network

Cardiologs
Schematic representation of a deep neural network, showing how more complex features are captured in deeper layers. (Layer images from H. Lee et al.)
DEEP NEURAL NETWORK TRAINING

1. DATASET
- 150,000 Resting ECGs
- 10,000 Holters
- Reviewed by cardiologists

2. DNN Structure
- Adapted from other domains (Krizhevsky et al.)

3. TRAINING
- 20 second strips
- AFIB/non-AFIB label

DR STEPHEN SMITH
ER Physician,
Hennepin County
Medical Center,
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DR ARNAUD ROSIER
Electrophysiologist,
Hôpital Jacques Cartier,
Massy

DR PIERRE TABOULET
Cardiologist & ER
Physician
Hôpital Saint-Louis, Paris
## PERFORMANCE EVALUATION

MIT-BIH Arrythmia database  48 patients, diverse arrythmias  At least 3 EPs in agreement

<table>
<thead>
<tr>
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<th>Acc</th>
<th>Sens</th>
<th>Spe</th>
<th>PPV</th>
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<tr>
<td>Cardiologs</td>
<td>99.0%</td>
<td>96.8%</td>
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<td>Colloca et al., 2013</td>
<td>85.5%</td>
<td>96.3%</td>
<td>88.8%</td>
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POWER OF DEEP NEURAL NETWORKS

Quantity of training data impacts accuracy

Accuracy Score comparison

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<th>Training set recordings</th>
<th>Training set duration</th>
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<tr>
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<td>Colloca et al., 2013</td>
<td>40</td>
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CONCLUSION

- Full machine learning approach
- Surpasses state-of-the-art performance
- Demonstrates the power of deep learning on huge database

Want to find out more about Cardiologs?
Get in touch! jia@cardiologs.com
A1: CAPTURING THE P-WAVE MORPHOLOGY

Sinus Rhythm

Atrial Fibrillation
A2: MIT-BIH ARRYTHMIA LIMIT

Annotated as VT in MIT-BIH. (MIT-BIH recording #223)
### A3: MIT AFIB DATABASE

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<th>PPV</th>
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<td>99.54%</td>
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<td>Zhou et al., 2013</td>
<td>96.14%</td>
<td>97.03%</td>
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A4: 12-LEADS DETECTION COMPARISON