CSD-AFNet:

Computationally Efficient Atrial Fibrillation Classification from ECGs using 2D Causal Strided Dilated Convolutions

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Time series team

ECG · Atrial Fibrillation · Deep Learning · Computational Efficiency · FPP-Convs

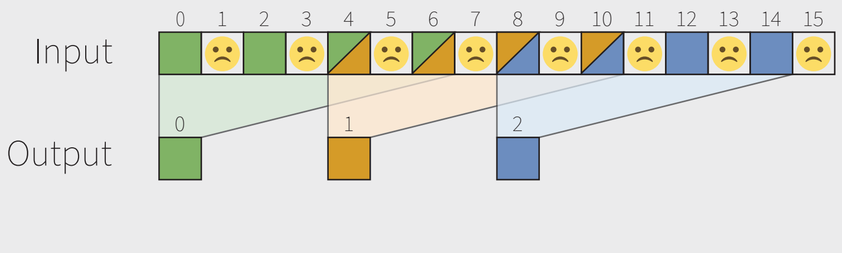
Motivation

- **ResNet models** (e.g., Attia) achieve **SOTA AFib classification** but are **computationally heavy**, with many parameters and FLOPs
- **Lightweight models** (e.g., AFibri-Net) enable **deployment on edge devices** but **sacrifice diagnostic accuracy**
- **Intermediate approaches** (e.g., ECGencode) help **balance** SOTA accuracy with reduced cost, but still **retain inefficiencies**

Goal: SOTA performance at lowest computational cost

Idea: **Reduce ECGencode's computational cost** by replacing **variable-length kernels** with a **fixed-size convolution** using **varying dilation rates and striding** for long temporal spans

Naive approach

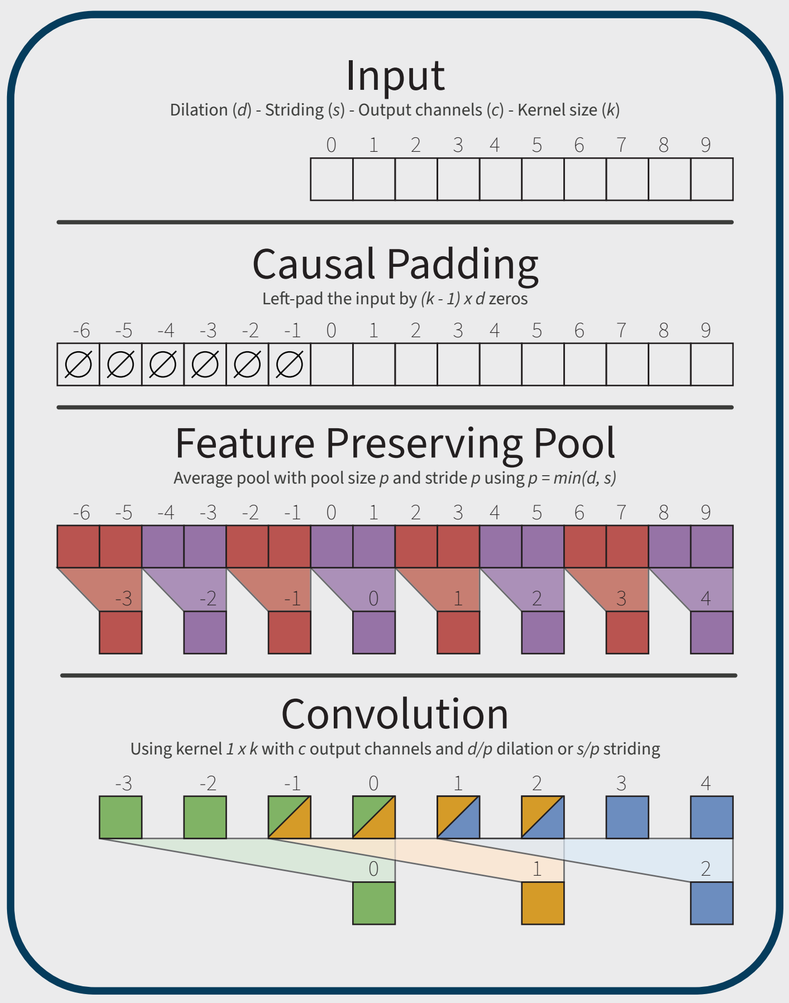


Problems

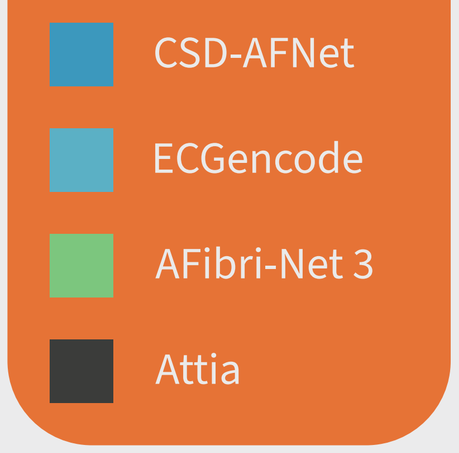
- **Skipped inputs**: feature loss when stride and dilation overlap
- **Future leakage**: outputs depend on future time points

Solution: Novel FPP-Conv with 2D Causal Padding

- **Preserves all features**
  No skipped inputs when combining stride and dilation
- **Enforces causality**
  Outputs depend only on past and present time points
- **Efficient temporal reach**
  Long-range coverage with minimal FLOPs
- **Supports stacking**
  Consistent output size for multiple temporal scales



Histogram





Results, Conclusion & Future Work

- **CSD-AFNet** delivers **SOTA AFib classification** for **NSR**, **detection**, and **prediction** on **CODE-15%** and **PTB-XL (OOD)**, matching **Attia** and **ECGencode**, while **outperforming AFibri-Net 3**
- **Computational cost is reduced by 71x in parameters** and **122x in FLOPs** versus **the ResNet baseline**, making **CSD-AFNet the most efficient model**, enabling **GPU-light training** and **real-time inference on CPU-only medical edge devices**
- **Future work**: **ablation study** of **FPP-Conv vs. 2D Causal Padding**, **single-lead adaptation** for **wearables**, and **on-device energy profiling**

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Title

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