The Designs of Ultra-lightweight Time-Series [2D+t] Classifier Using AutoML

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Data Acquisition Methods

- **Ultrasound Probe Data**
- **Digital Camera Image**
- **Still Images**
- **Data Pre-processing**

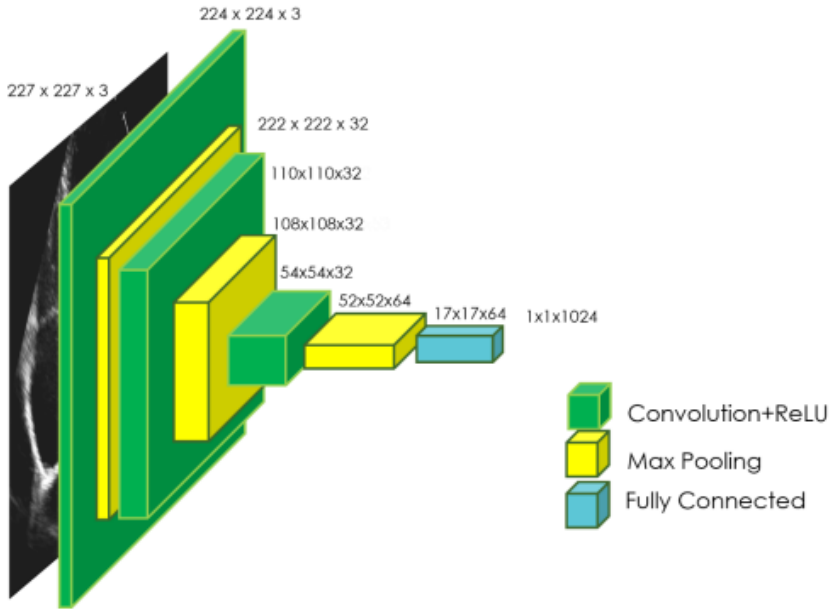
Data Storage Strategy

- **Scalability**
- **Accessibility**
- **Latency Issues**
- **Throughput**
- **Parallel Access**

Implemented Algorithms

- Gaussian Process, probabilistic model applied to multiclass data to simultaneously solve classification, regression problems
- Deep learning model featuring multi-stream, multi-variate data, simultaneously trained to predict quantitative score on image quality in real-time
- DL supervised model featuring (2D+t) time series for sequential frame classification
- Semi-supervise ensemble model featuring pattern recognition and automatic label annotation

CardioQNet: The Ultra-light Weight 2D+t Multivariate Classifier



ConvNet Layer1	ConvNet Layer2	ConvNet Layer3
32: 11x11	32:7x7	64:32x32
BN	BN	BN
32:4x4	32:4x4	64:4x4

Figure 3.17: CardioQNet - The ultralight-weight architecture, derived using semi-automatic neural architecture search method. This is optimised for 2-dimensional echocardiographic classification and regression tasks.

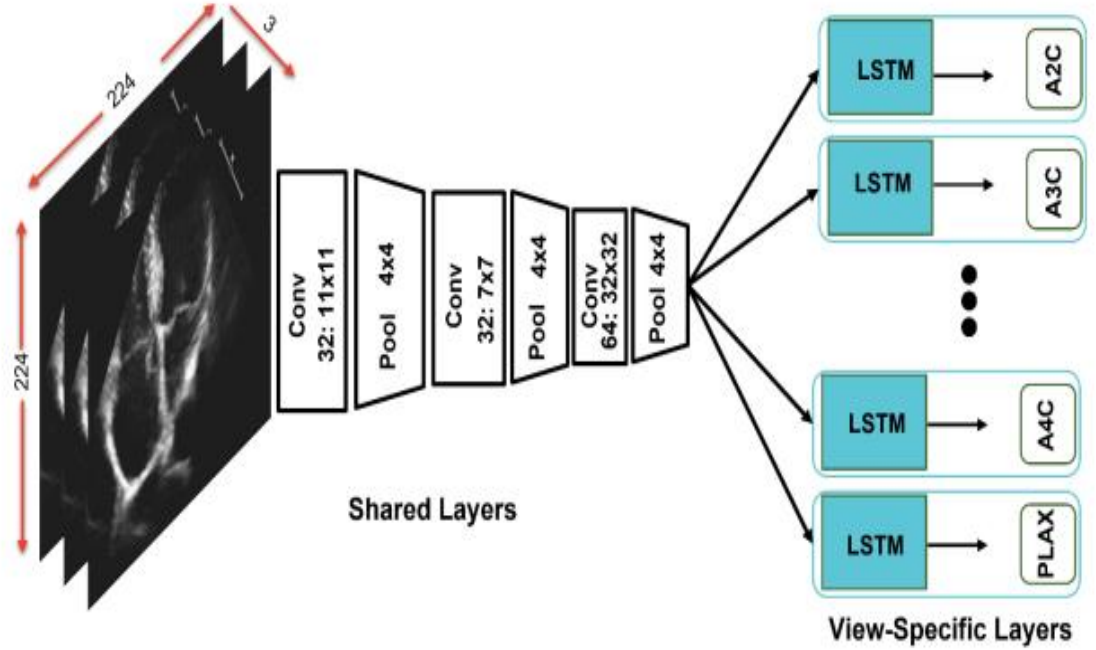
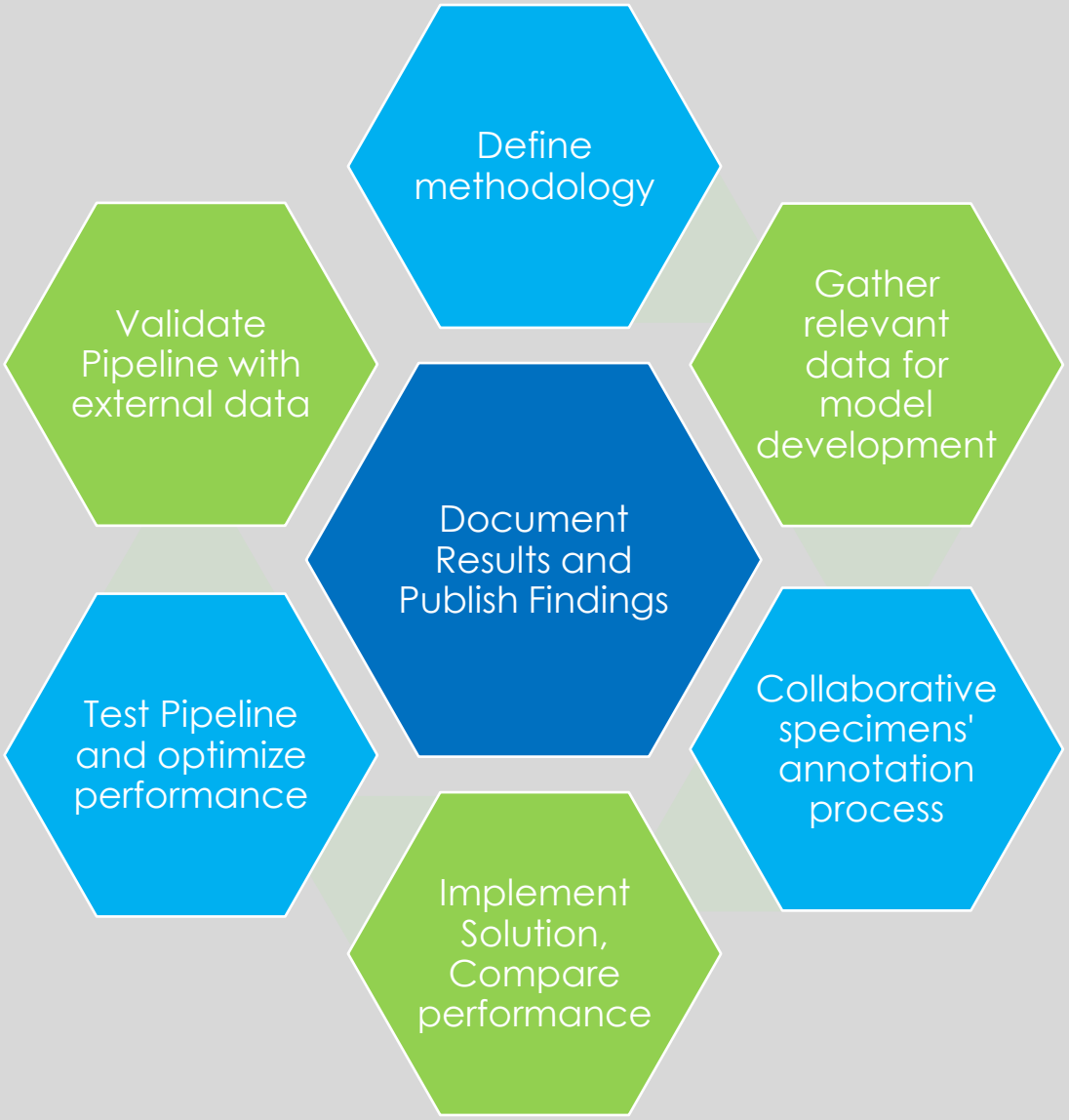


Figure 4.3: The lightweight hybrid architecture in a multi-stream configuration for echocardiography frame classification. CardioQNet is used for weight sharing feeding 14 view-specific layers in the LSTM. Numbers of kernels in each layer and their corresponding sizes are shown accordingly.

Achieved Objectives

- Objectively Quantified the anatomical structure of echocardiograms in real-time and automatically identify the view types, within the selection of 14 apical views.
- Characterize and identify the pathological element within a given 2D/3D echocardiographic image.
- Guide Operators in Probe handling, probe transition and analysed the pathological element using onscreen objective indicators for best image acquisition and playbacks.



Research Outcomes

- The model was validated against known models with variable frame length and 224x224 spatial resolution: MobileNetv2, ResNet50 and VGG16 achieved 91.76%, 90.32% and 94.28% respectively. Also, the inference time of 15.8ms, 19.53ms, 30.76ms, respectively.
- The derived model (**CardioQNet**) outperformed all the chosen state-of-the-art models on 2D echo cine loop video in terms of inference speed (2.52ms), and accuracy (96.20%).

Research Impacts

- Clinical Antenatal Investigations
- Medical Emergencies (POCUS scenarios)
- Diagnosis of Infarction
- Cardiac prognosis and risk factor treatment
- Obstetrician & Gynaecological investigation
- Accelerate learning curve for novice users

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