**Model Optimization and Tuning Phase Report**

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| Date | 22 JUNE 2025 |
| Project Title | Classification of Arrhythmia by Using Deep Learning with 2-D ECG Spectral Image Representation |
| Maximum Marks | 10 Marks |

**Model Optimization and Tuning Phase**

The Model Optimization and Tuning Phase involves refining machine learning models for peak performance. It includes optimized model code, fine-tuning hyperparameters, comparing performance metrics, and justifying the final model selection for enhanced predictive accuracy and efficiency.

**Hyperparameter Tuning Documentation (6 Marks):**

| **Model** | **Tuned Hyperparameters** | **Optimal Values** |
| --- | --- | --- |
| Shallow CNN | Conv2D filters, Dense units, Dropout rate | 16 filters, 64 units, Dropout 0.3 |
| Deep CNN | Conv2D filters, Dense units, Dropout rate | 32/64/128 filters, 256 units, Dropout 0.5 |
| CNN + LSTM | Conv2D filters, LSTM units, Dense units, Dropout rate | 32/64 filters, 64 LSTM units, 128 units, Dropout 0.5 |
| CNN + GRU + Attention | Conv2D filters, GRU units, Attention, Dense units, Dropout rate | 32/64 filters, 64 GRU units, Attention, 128 units, Dropout 0.5 |

**Performance Metrics Comparison Report (2 Marks):**

| **Model** | **Optimized Metric (Macro F1 Score %)** |
| --- | --- |
| Shallow CNN | 67% |
| Deep CNN | 91% |
| CNN + LSTM | 80% |
| CNN + GRU + Attention | 60% |

**Final Model Selection Justification (2 Marks):**

**Final Model**  
Deep CNN

**Reasoning**  
The Deep CNN model was selected for its superior performance, exhibiting the highest macro F1 score (91%) during model evaluation. Its ability to extract complex features from 2-D ECG spectral images, minimize misclassification, and optimize predictive accuracy aligns with the project objectives, justifying its selection as the final model