# Comparative Analysis of Attention Mechanisms for Automatic Modulation Classification in Radio Frequency Signals

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***Abstract*— Automatic Modulation Classification (AMC) is one of the crucial components in next-generation networks, particularly cognitive radio systems and spectrum management tasks. This study provides a comparative analysis of three attention mechanisms, namely baseline multi-head attention, causal attention, and sparse attention, integrated with Convolutional Neural Networks (CNNs) for radio frequency (RF) signal classification. It proposes a hybrid architecture combining CNN and Transformer models. This architecture uses different attention patterns to capture temporal dependencies in I/Q samples from the dataset, consisting of 11 modulations (8 digital and 3 analog) generated under simulated interference conditions. The experimental results indicate that the baseline attention achieves the highest accuracy of 85.05\%. On the other hand, causal and sparse attention mechanisms deliver significant computational advantages, reducing inference time by 83\% and 75\%, respectively, and show classification performance above 84\%. In addition, distinct attention patterns for different modulation schemes provide the design of efficient attention mechanisms for real-time radio signal processing tasks.**

***(Pt9)Keyword*— Automatic Modulation Classification, Attention Mechanisms, Deep Learning, Radio Frequency, Convolutional Neural Networks, Transformer Architecture**

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