High-Level Model Design

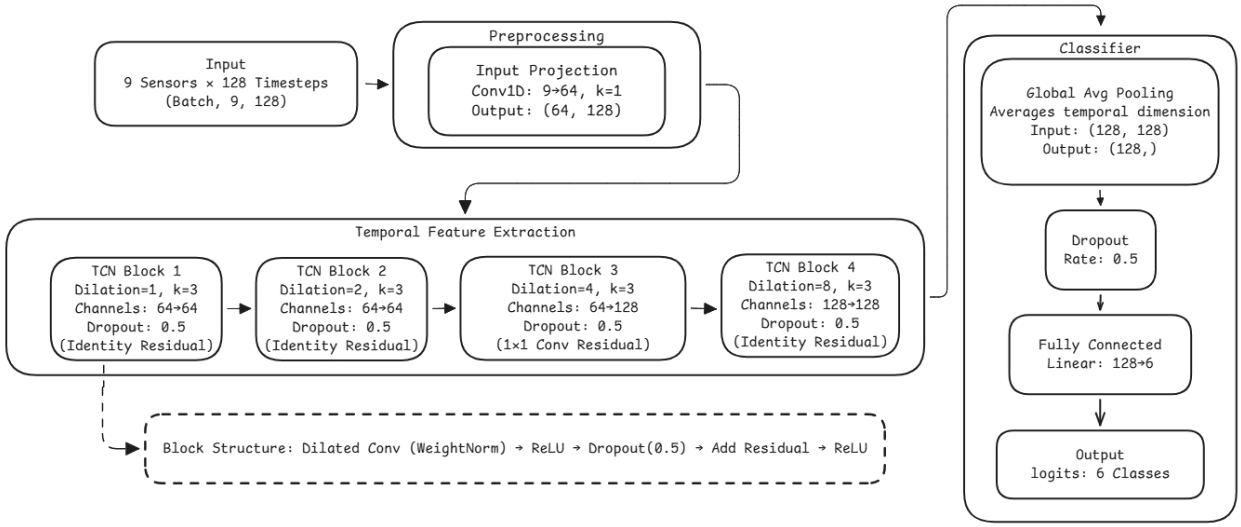

Fig 1: High-Level Model Design (**Temporal Convolutional Network (TCN)**)

Layer-by-Layer Breakdown

#	Layer	Configuration	Parameters	Output Shape
1	Input Projection	Conv1d (k=1), 9 → 64 channels	(64 * 9 * 1) + 64 = 640	(64, 128)
2	TCN Block 1	Dilation d=1, 64 → 64 channels	(64 * 64 * 3) + 64 + 64 = 12,416	(64, 128)
3	TCN Block 2	Dilation d=2, 64 → 64 channels	(64 * 64 * 3) + 64 + 64 = 12,416	(64, 128)
4	TCN Block 3	Dilation d=4, 64 → 128 channels	[(64 * 128 * 3) + 128 + 128] + [(128 * 64 * 1) + 128 +128] = 33,280	(128, 128)
5	TCN Block 4	Dilation d=8, 128 → 128 channels	(128 * 128 * 3) + 128 +128 = 49,408	(128, 128)
6	Global Avg Pool	Average across timesteps	0	128
7	Classifier	Fully Connected, 128 → 6 classes	(128 * 6) + 6 = 774	6
			Total Params = 108,934	

Fig 2: Layer-By-Layer breakdown

Key Design Choices

- **Dilated Causal Convolutions:** Schedule [1,2,4,8] efficiently expands the receptive field; causal padding ensures predictions only use past/current data. Better than RNN (parallel processing, no vanishing gradients) and simpler than Transformers (fewer parameters, faster training).
- **Progressive Channel Expansion:** Start with 64 channels for basic patterns, expand to 128 for complex combinations. Balances capacity (accuracy) vs efficiency (speed).
- **Weight Normalization:** Reparameterizes convolution weights for stable gradients with dilated convolutions. More effective than batch normalization for temporal data.
- **Residual Connections:** Enable training 4+ layers without degradation.
- **Global Average Pooling:** Aggregates entire sequence robustly; reduces parameters vs fully-connected layers; provides temporal translation invariance.
- **Model Size (~108K params):** Fast training on GPU while maintaining capacity for training samples.

References

1. locuslab/TCN: Sequence modeling benchmarks and temporal convolutional networks
2. NAC-TCN: Temporal Convolutional Networks with Causal Dilated Neighborhood Attention for Emotion Understanding
3. alexmehta/NAC-TCN-TCNs-with-Causal-NA: ICIVP 2023 Best Presentation Award | Code for NAC-TCN: Temporal Convolutional Networks with Causal Dilated Neighborhood Attention for Emotion Understanding
4. Convolutions in Autoregressive Neural Networks