SpikF: Spiking Fourier Network for Efficient Long-term Prediction

Wenjie Wu, Dexuan Huo, Hong Chen
Tsinghua University

Motivation

SNNs' application in long-term prediction tasks remains underexplored, which is primarily due to:

- Current SNN encoding methods are unable to effectively encode long temporal information
- The absence of proper positional encoding for spiking self-attention restricts Spiking Transformer from effectively utilizing positional information

Efficient Long-term Prediction with Patch Mechanism and Fourier Transform
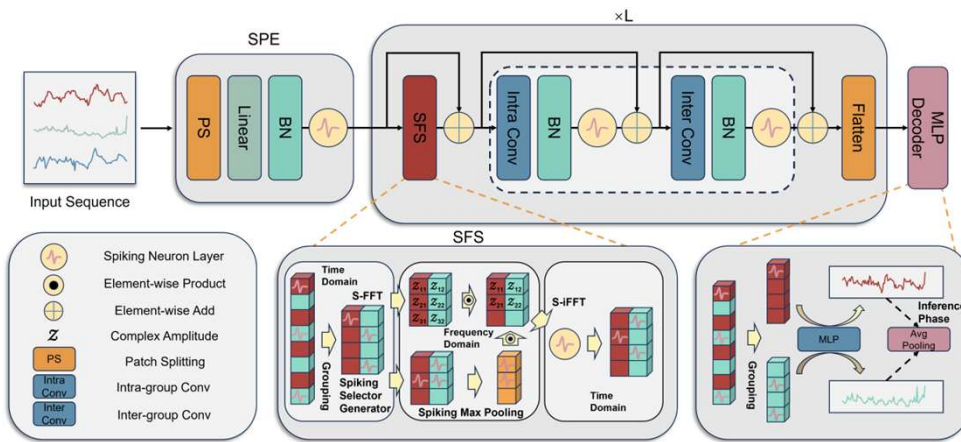
1. Spiking Patch Encoder: encode input sequence in patches to handle longer input sequences

2. Spiking Frequency Selector: select frequency components to establish long-range temporal dependencies within the input sequence and between the sequence and prediction target

3. Evaluation Across Eight Real-world Long-term Time-series Benchmarks: SpikF achieves an averaged 1.9% reduction in Mean Absolute Error (MAE) compared to state-of-the-art models, while lowering total energy consumption by 3.16×.

Experiments

Long-term Prediction

Model	SpikF		iTransformer		RLinear		PatchTST		Crossformer		TimesNet		DLinear		SCINet		Autoformer	
Metric	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE
ECL	0.183	0.275	**0.178**	**0.270**	0.219	0.298	0.205	0.290	0.244	0.334	0.192	0.295	0.212	0.300	0.268	0.365	0.227	0.338
Weather	**0.245**	**0.265**	0.258	0.278	0.272	0.291	0.259	0.281	0.259	0.315	0.259	0.287	0.265	0.317	0.292	0.363	0.338	0.382
ETTh1	**0.440**	**0.428**	0.454	0.447	0.446	0.434	0.469	0.454	0.529	0.522	0.458	0.450	0.456	0.452	0.747	0.647	0.496	0.487
ETTh2	**0.372**	**0.394**	0.383	0.407	0.374	0.398	0.387	0.407	0.942	0.684	0.414	0.427	0.559	0.515	0.954	0.723	0.450	0.459
ETTm1	0.388	**0.385**	0.407	0.410	0.414	0.407	**0.387**	0.400	0.513	0.496	0.400	0.406	0.403	0.407	0.485	0.481	0.588	0.517
ETTm2	**0.281**	**0.320**	0.288	0.332	0.286	0.327	**0.281**	0.326	0.757	0.610	0.291	0.333	0.350	0.401	0.571	0.537	0.327	0.371
Traffic	0.497	0.296	**0.428**	**0.282**	0.626	0.378	0.481	0.304	0.550	0.304	0.620	0.336	0.625	0.383	0.804	0.509	0.628	0.379
Exchange	0.360	**0.402**	0.360	0.403	0.378	0.417	0.367	0.404	0.940	0.707	0.416	0.443	**0.354**	0.414	0.750	0.626	0.613	0.539

Different Look-back Window and Prediction Length
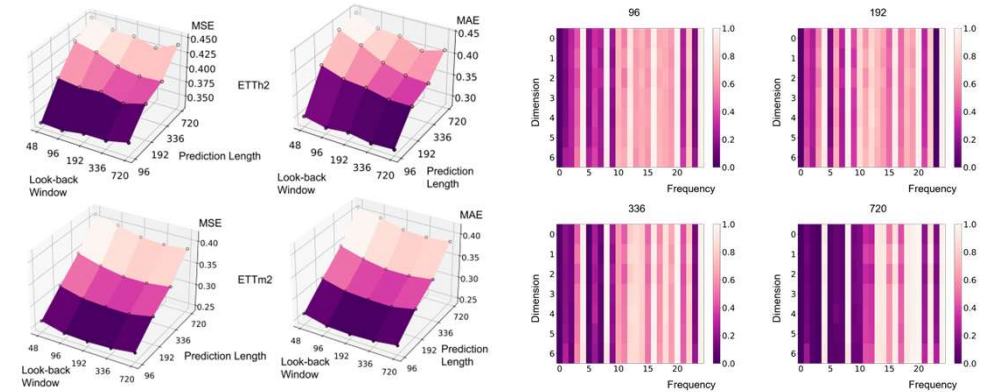
Sensitivity to Patch Dimension