DBLoss: Decomposition-based Loss Function for Time Series Forecasting

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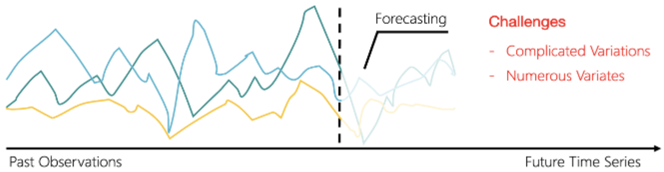
Introduction to Time Series

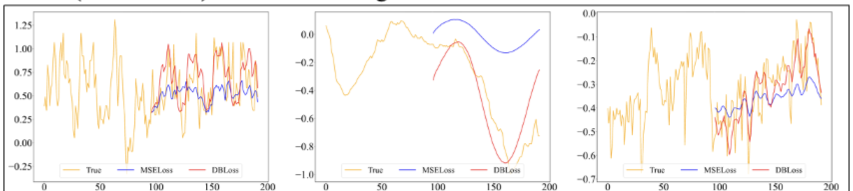
- Time series data refers to data recorded in chronological order, found in various aspects of daily life and industrial production.

Multivariate Time Series Forecasting aims to predict the next F future timestamps, formulated as $Y = < X_{:,T+1}, \cdots, X_{:,T+F} > \in \mathbb{R}^{N\times F}$ based on the historical time series $X = < X_{:,1}, \cdots, X_{:,T} > \in \mathbb{R}^{N\times T}$ with N channels and T timestamps.



Challenges in Time Series Modeling

- We observe that current distance-based loss functions (such as MSE) have the following limitations:
  - they may make poor seasonal predictions.
  - they may make poor trend predictions.
  - they may make both poor seasonal and trend predictions.

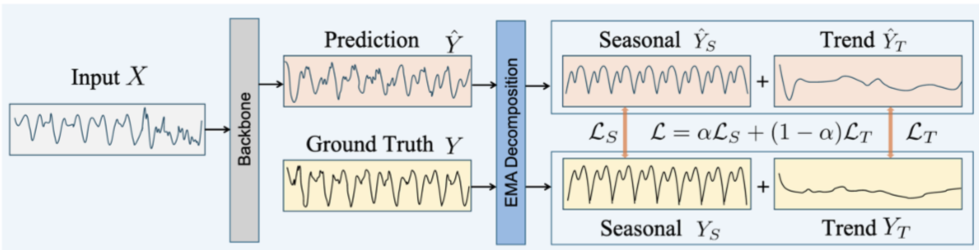


(a) Poor Seasonal Predictions (b) Poor Trend Predictions (c) Poor Seasonal and Trend Predictions

- Even when decomposition techniques are applied in the forward propagation, the seasonality and trend within the forecasting horizon are not effectively modeled, indicating that the inductive bias is not well applied to the predictions.

DBLoss

- We propose a simple yet effective loss function for time series forecasting, called DBLoss, which can refine the characterization and representation of time series through decomposition within the forecasting horizon.
- The proposed DBLoss is generally applicable to arbitrary deep neural networks with negligible cost. By introducing DBLoss into the baseline, we have achieved performance that generally surpasses the state-of-the-art on eight real-world datasets.



Results

Table 3: Zero-shot forecasting results on ETT datasets. The forecasting horizon is 720. The parameters for the baselines are kept consistent with those of TFB [Qiu et al., 2024]. The better results are highlighted in **bold**.

Model	iTransformer				Amplifier				PatchTST				DLinear			
Loss	Ori		DBLoss		Ori		DBLoss		Ori		DBLoss		Ori		DBLoss	
Metric	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE
ETTh1→ETTh2	0.461	0.470	**0.434**	**0.446**	**0.393**	**0.427**	0.401	0.431	0.402	0.437	**0.389**	**0.427**	0.647	0.573	**0.542**	**0.520**
ETTh1→ETTm1	1.061	0.676	**0.771**	**0.592**	0.777	**0.571**	**0.758**	0.576	0.753	0.590	**0.722**	**0.570**	0.754	0.602	**0.735**	**0.584**
ETTh1→ETTm2	0.454	0.447	**0.434**	**0.420**	**0.406**	0.415	0.412	**0.414**	0.403	0.414	**0.400**	**0.410**	0.640	0.566	**0.535**	**0.510**
ETTh2→ETTh1	0.672	0.593	**0.557**	**0.521**	0.678	0.592	**0.530**	**0.515**	0.593	0.556	**0.484**	**0.490**	0.506	0.521	**0.450**	**0.477**
ETTh2→ETTm1	0.969	0.659	**0.802**	**0.594**	0.761	0.585	**0.714**	**0.564**	0.762	0.577	**0.738**	**0.551**	0.752	0.608	**0.738**	**0.579**
ETTh2→ETTm2	**0.417**	0.428	0.436	**0.422**	0.403	0.417	**0.403**	**0.415**	**0.393**	0.409	0.395	**0.404**	0.787	0.629	**0.580**	**0.526**
ETTm1→ETTh1	0.705	0.598	**0.528**	**0.516**	0.500	0.494	**0.482**	**0.488**	0.710	0.594	**0.553**	**0.534**	0.460	0.481	**0.445**	**0.468**
ETTm1→ETTh2	0.433	0.460	**0.409**	**0.444**	0.425	0.446	**0.421**	**0.445**	**0.418**	**0.451**	0.431	0.452	0.427	0.464	**0.404**	**0.444**
ETTm1→ETTm2	**0.369**	0.389	0.370	**0.387**	**0.369**	0.384	0.372	**0.384**	0.370	0.391	**0.367**	**0.384**	0.389	0.416	**0.367**	**0.394**
ETTm2→ETTh1	1.001	0.704	**0.775**	**0.613**	0.542	0.524	**0.479**	**0.491**	0.896	0.695	**0.617**	**0.577**	0.488	0.497	**0.460**	**0.481**
ETTm2→ETTh2	0.477	0.486	**0.456**	**0.468**	0.444	0.464	**0.414**	**0.439**	0.412	0.449	**0.400**	**0.431**	0.415	0.452	**0.410**	**0.445**
ETTm2→ETTm1	0.662	0.566	**0.551**	**0.498**	0.652	0.547	**0.478**	**0.452**	0.484	0.451	**0.452**	**0.429**	0.449	0.439	**0.436**	**0.430**

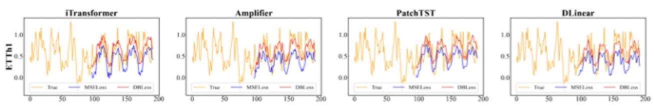


Figure 5: Forecasting visualization comparing DBLoss and MSE loss as objective functions.

Table 2: Comparison between the proposed DBLoss and other loss functions. The model is DLinear and we report the result of three datasets-ETTh2, ETTm1, and Traffic. The best results are highlighted in **bold**, and the second-best results are highlighted in underline.

Dataset		ETTh2					ETTm1					Traffic				
Forecast horizon		96	192	336	720	Avg	96	192	336	720	Avg	96	192	336	720	Avg
Ori	MSE	0.300	0.387	0.490	0.704	0.470	0.300	0.336	0.367	0.419	0.356	**0.395**	**0.407**	0.417	0.454	0.418
	MAE	0.364	0.423	0.487	0.597	0.468	0.345	0.366	0.386	0.416	0.378	0.275	0.280	0.286	0.308	0.287
TILDE-Q (2022)	MSE	0.287	0.362	0.425	0.599	0.418	0.302	0.336	0.371	0.425	0.359	0.416	0.422	0.423	0.461	0.431
	MAE	0.345	0.395	0.445	0.551	0.434	0.342	0.362	0.386	0.417	0.377	0.294	0.296	0.293	0.316	0.300
FreDF (2025e)	MSE	0.284	0.362	0.420	0.587	0.413	0.302	0.333	0.363	**0.415**	0.353	0.398	0.408	0.416	0.452	0.419
	MAE	**0.342**	0.396	0.445	0.546	0.432	0.344	0.363	0.381	0.411	0.375	**0.270**	0.275	0.280	0.302	0.282
PSLoss (2025)	MSE	**0.283**	0.358	0.411	0.614	0.417	0.296	0.332	**0.361**	0.416	**0.351**	0.398	0.408	0.416	0.452	0.419
	MAE	0.343	0.393	0.434	0.549	0.430	0.339	0.361	0.380	0.413	0.373	**0.270**	**0.274**	**0.279**	0.299	0.281
DBLoss (Ours)	MSE	0.284	**0.357**	**0.407**	**0.586**	**0.409**	**0.295**	**0.331**	**0.361**	**0.415**	**0.351**	0.396	**0.407**	**0.415**	**0.449**	**0.417**
	MAE	**0.342**	**0.390**	**0.430**	**0.533**	**0.424**	**0.337**	**0.358**	**0.378**	**0.409**	**0.370**	**0.270**	**0.274**	**0.279**	**0.298**	**0.280**

Table 4: Foundation models results in the 5% few-shot setting. The table reports average MSE and MAE for four forecasting lengths $F \in \{96, 192, 336, 720\}$. The parameters for the baselines are kept consistent with those of TSFM-Bench [Li et al., 2025c]. The better results are highlighted in **bold**. Full results are provided in Table 10 of Appendix G

Model	GPT4TS				CALF				TTM				UniTS			
Loss	Ori		DBLoss		Ori		DBLoss		Ori		DBLoss		Ori		DBLoss	
Metric	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE
ETTh1	0.467	0.470	**0.453**	**0.462**	0.443	0.454	**0.433**	**0.446**	0.405	0.425	**0.395**	**0.417**	0.436	0.434	**0.425**	**0.427**
ETTh2	0.373	0.414	**0.368**	**0.406**	0.373	0.407	**0.368**	**0.404**	0.342	0.383	**0.332**	**0.378**	0.372	0.405	**0.357**	**0.393**
ETTm1	0.388	0.404	**0.377**	**0.394**	0.372	0.396	**0.358**	**0.382**	0.356	0.376	**0.354**	**0.372**	0.377	0.402	**0.362**	**0.386**
ETTm2	0.278	0.335	**0.266**	**0.320**	0.271	0.332	**0.259**	**0.316**	0.258	0.313	**0.257**	**0.308**	0.292	0.344	**0.270**	**0.320**
Solar	0.262	0.335	**0.254**	**0.279**	**0.229**	**0.297**	0.246	0.300	**0.219**	0.269	0.224	**0.266**	**0.206**	0.261	0.214	**0.246**
Weather	0.253	0.293	**0.248**	**0.284**	0.238	0.277	**0.236**	**0.272**	**0.225**	0.260	**0.225**	**0.256**	**0.230**	0.269	0.231	**0.260**
Electricity	**0.207**	0.317	**0.207**	**0.309**	0.172	0.268	**0.171**	**0.264**	0.179	0.277	**0.178**	**0.274**	**0.180**	0.275	0.181	**0.274**
Traffic	0.433	0.309	**0.428**	**0.295**	0.435	0.316	**0.433**	**0.309**	0.484	0.341	**0.481**	**0.339**	0.422	0.289	**0.420**	**0.282**