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TACTiS-2

Better, Faster, Simpler Attentional Copulas for Multivariate Time Series

ICLR 2024

Arjun Ashok

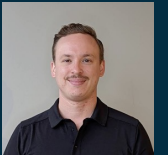ServiceNow Research, MILA, Université de Montréal

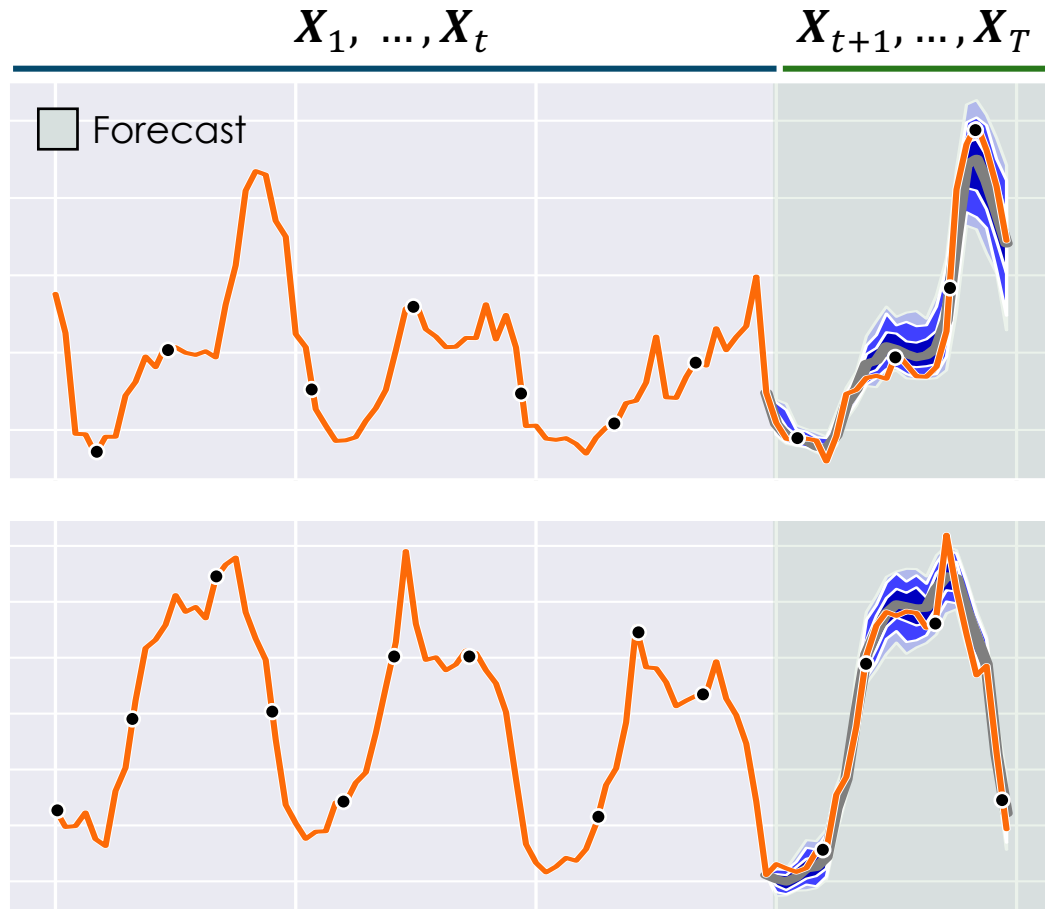Arjun Ashok

Étienne Marcotte

Valentina Zantedeschi

Alexandre Drouin

Nicolas Chapados

Multivariate probabilistic forecasting

$X_1, \ldots, X_t$

$X_{t+1}, \ldots, X_T$

☐ Forecast

Goal: Given observations from **multiple** time series, estimate the **joint distribution** of their **future** values.

$$P_\theta(X_{t+1}, \ldots, X_T \mid X_1, \ldots, X_t)$$

Forecast   **History**

ML task: train a model that outputs the parameters θ of this distribution

Model properties requirements

1 **Non-parametric** estimator

2 **Arbitrary** prediction **tasks**

3 Compatible with **covariates**

4 Robust to **missing** values

5 Highly **flexible**

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TACTiS-2

A general purpose multivariate probabilistic
forecasting model

TACTiS-2 architecture

★ Transformer-based encoder/decoder

★ Two independent encoders: one for the marginals, and one for the copula

★ The marginals encode the univariate distributions

★ The copula encodes the multivariate dependencies

★ Training: first only the marginals, then only the copula
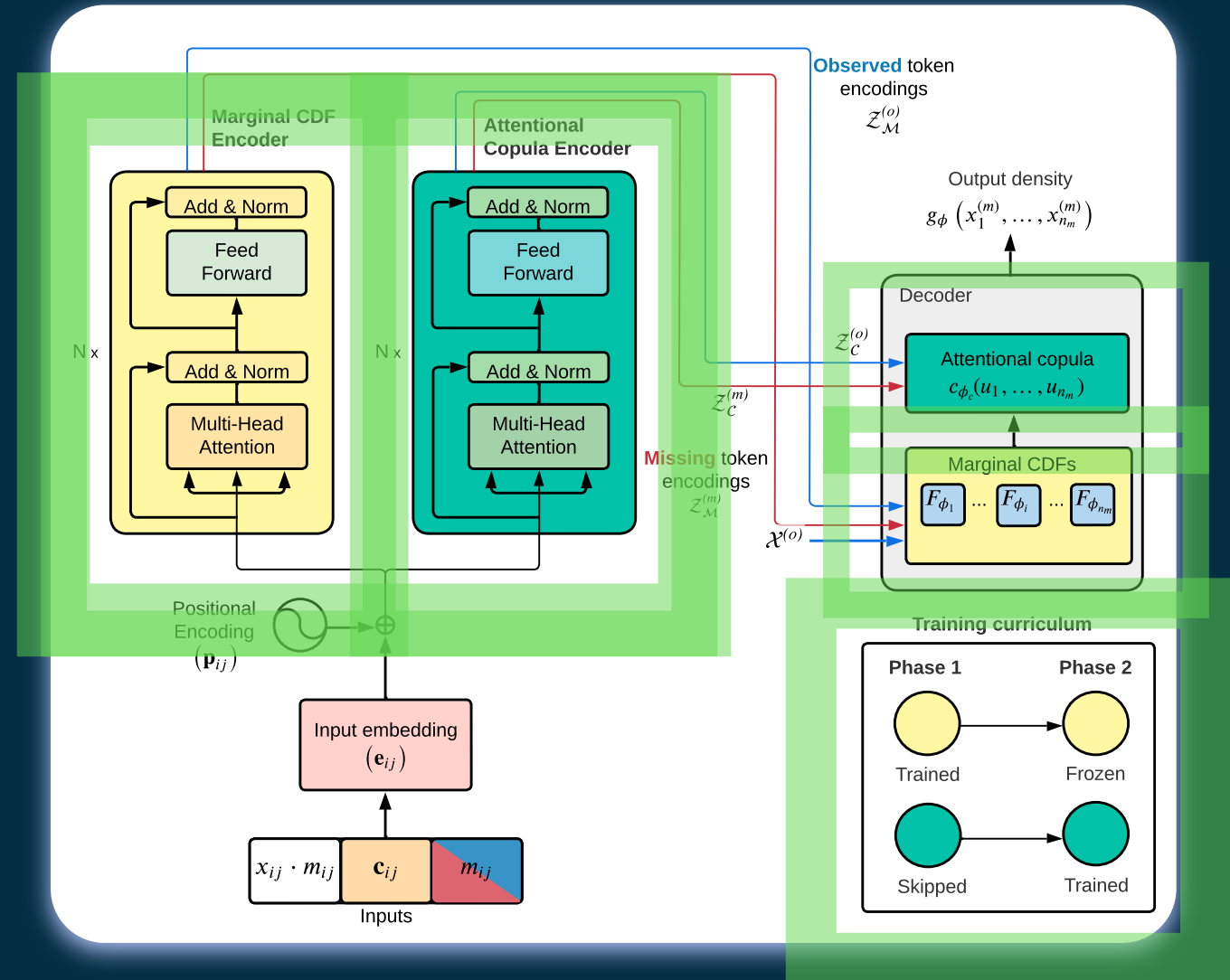
How good is TACTiS-2 at forecasting?

**Takeaway:** TACTiS-2 achieves state-of-the-art accuracy *despite* its superior flexibility

CRPS-Sum means (± standard errors). Lower is better. Best results in bold.

| Model	electricity	fred-md	kdd-cup	solar-10min	traffic
Auto-ARIMA	0.077 ± 0.016	0.043 ± 0.005	0.625 ± 0.066	0.994 ± 0.216	0.222 ± 0.005
ETS	0.059 ± 0.011	0.037 ± 0.010	0.408 ± 0.030	0.678 ± 0.097	0.353 ± 0.011
TempFlow	0.075 ± 0.024	0.095 ± 0.004	0.250 ± 0.010	0.507 ± 0.034	0.242 ± 0.020
SPD	0.062 ± 0.016	0.048 ± 0.011	0.319 ± 0.013	0.568 ± 0.061	0.228 ± 0.013
TimeGrad	0.067 ± 0.028	0.094 ± 0.030	0.326 ± 0.024	0.540 ± 0.044	0.126 ± 0.019
GPVar	0.035 ± 0.011	0.067 ± 0.008	0.290 ± 0.005	0.254 ± 0.028	0.145 ± 0.010
TACTiS	0.021 ± 0.005	0.042 ± 0.009	0.237 ± 0.013	0.311 ± 0.061	$\mathbf{0.071 \pm 0.008}$
TACTiS-2	$\mathbf{0.020 \pm 0.005}$	$\mathbf{0.035 \pm 0.005}$	$\mathbf{0.234 \pm 0.011}$	$\mathbf{0.240 \pm 0.027}$	0.078 ± 0.008

Forecasting non-trivial distributions:
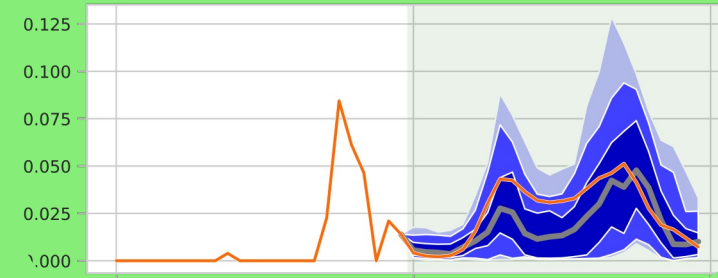
Interpolating missing values:
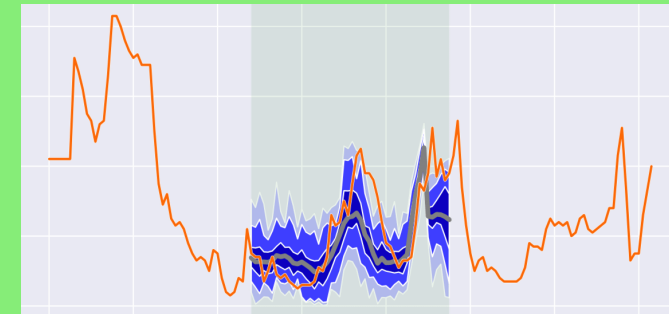
Forecasting irregular time series:
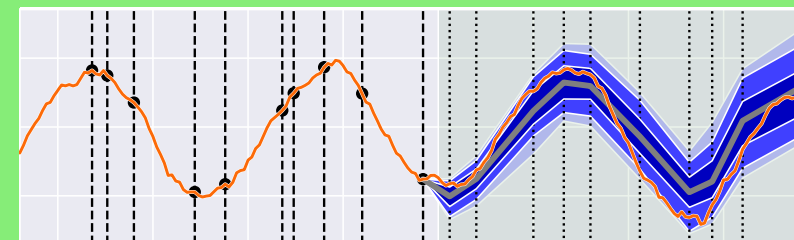
References

TACTIS-2: BETTER, FASTER, SIMPLER ATTENTIONAL COPULAS FOR MULTIVARIATE TIME SERIES

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https://github.com/ServiceNow/tactis

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Thank you