**ENIAC 2025**

FCKAN: Evaluating KAN for Time Series Classification and Extrinsic Regression

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What is a time series?

A time series is a sequence of n ordered values, as shown in the following equation:

$S = (s_1, s_2, \ldots, s_n)$, such that $s_t \in R^d$ for all $t \in [1, n]$, $d \in N^*$. When $d = 1$, we have the so-called **univariate** series, while if $d > 1$, it is called **multivariate**.
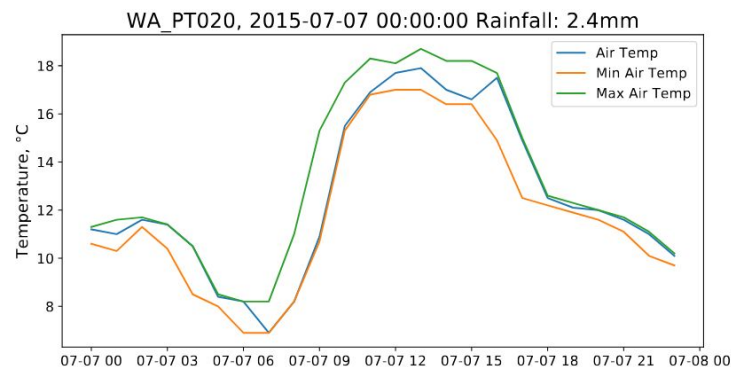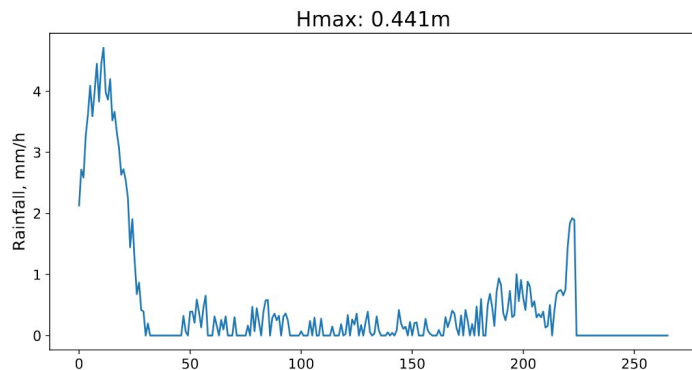
Tan, C.W., Bergmeir, C., Petitjean, F., Webb, G.I.: Monash University, UEA, UCR Time Series Extrinsic Regression Archive. arXiv preprint arXiv:2006.10996 (2020)

Time Series Classification (TSC)

For TSC, the **task** is to predict the label/class of each time series.
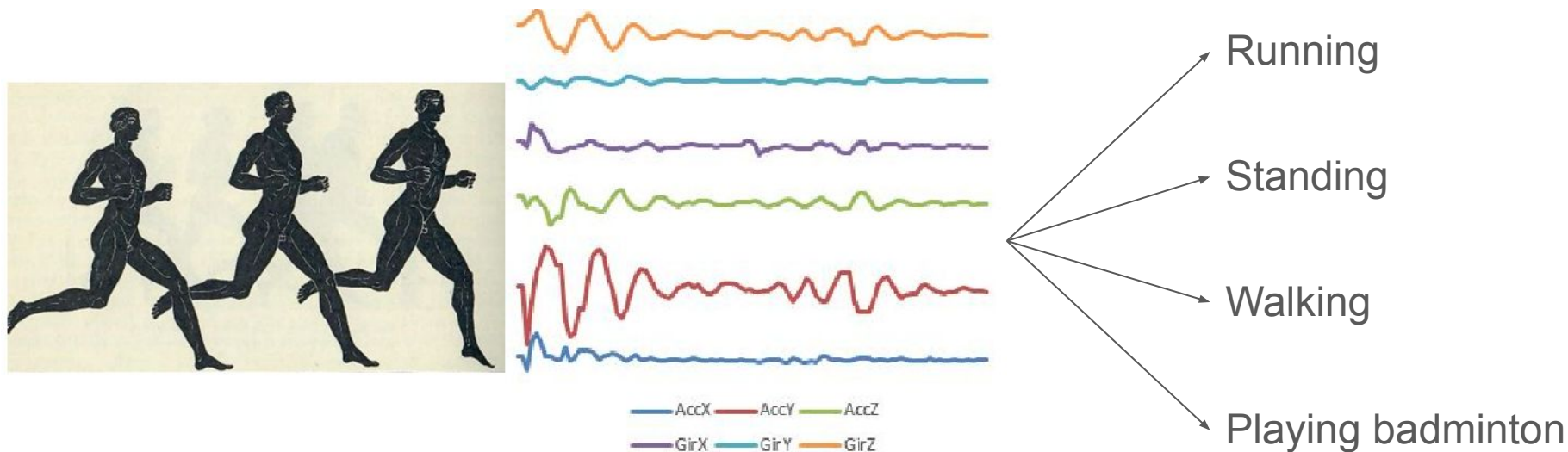
Bagnall, A., Dau, H.A., Lines, J., Flynn, M., Large, J., Bostrom, A., Southam, P., Keogh, E.: The UEA multivariate time series classification archive, 2018. arXiv preprint arXiv:1811.00075 (2018)

Time Series Extrinsic Regression (TSER)

For TSER, the **task** is to estimate a continuous value x_i that is not part of the time series domain (whereas in forecasting, the prediction is within the time series domain).
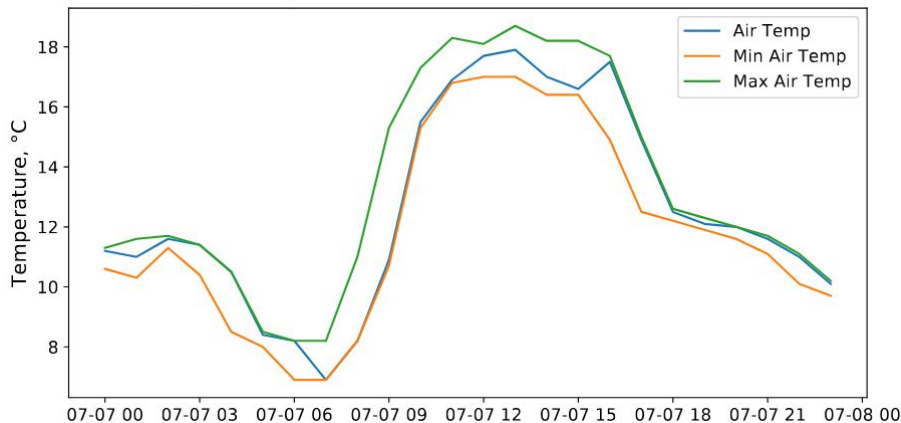
Total Daily Rainfall: 1.4mm

Tan, C.W., Bergmeir, C., Petitjean, F., Webb, G.I.: Monash University, UEA, UCR Time Series Extrinsic Regression Archive. arXiv preprint arXiv:2006.10996 (2020)
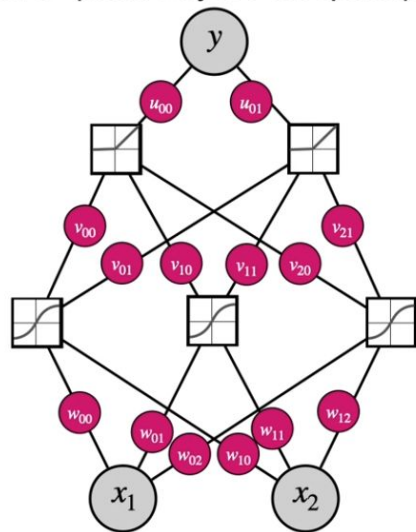
Kolmogorov-Arnold Network (KAN)
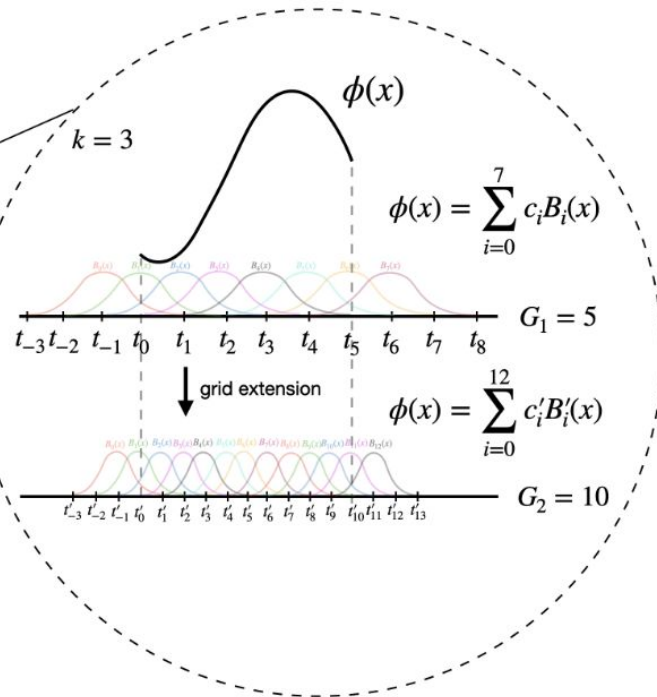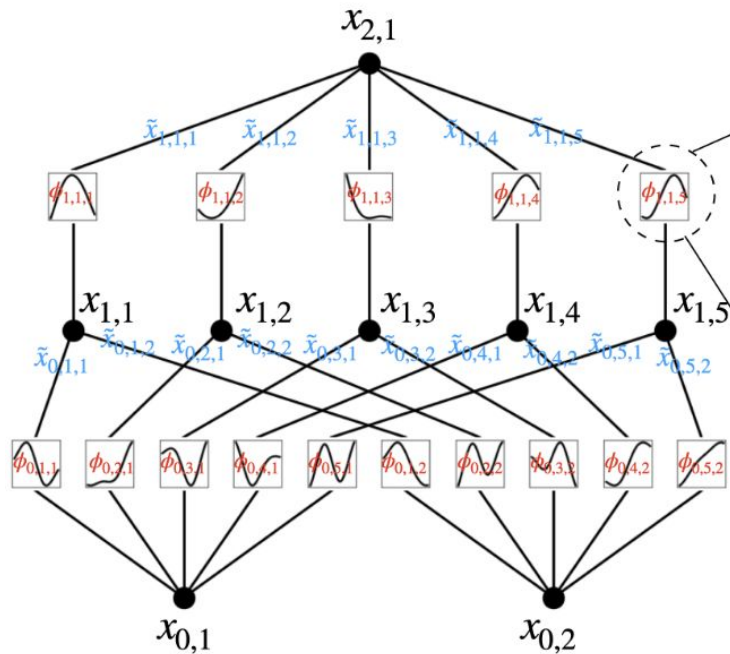
Liu, Z., Wang, Y., Vaidya, S., Ruehle, F., Halverson, J., Soljačić, M., Hou, T.Y., Tegmark, M.: KAN: Kolmogorov-Arnold Networks. arXiv preprint arXiv:2404.19756 (2025)
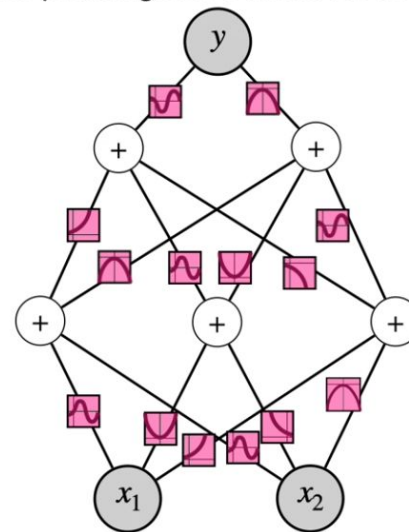
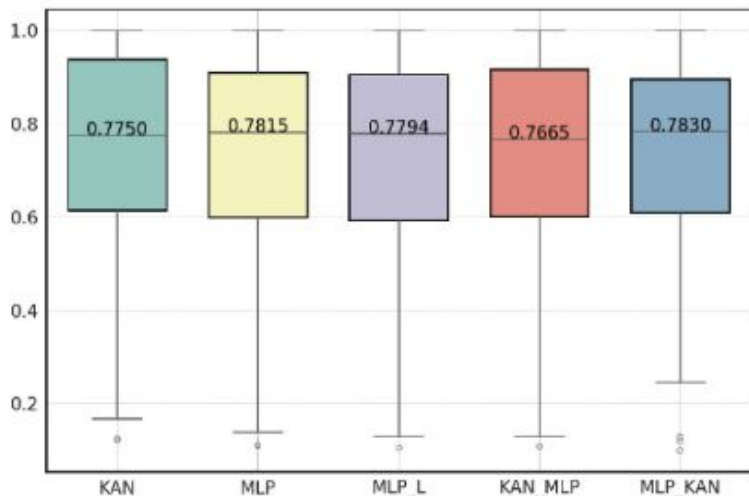# MultiLayer Perceptron (MLP) X KAN

Universal Approximation Theorem   **Kolmogorov–Arnold Representation Theorem**
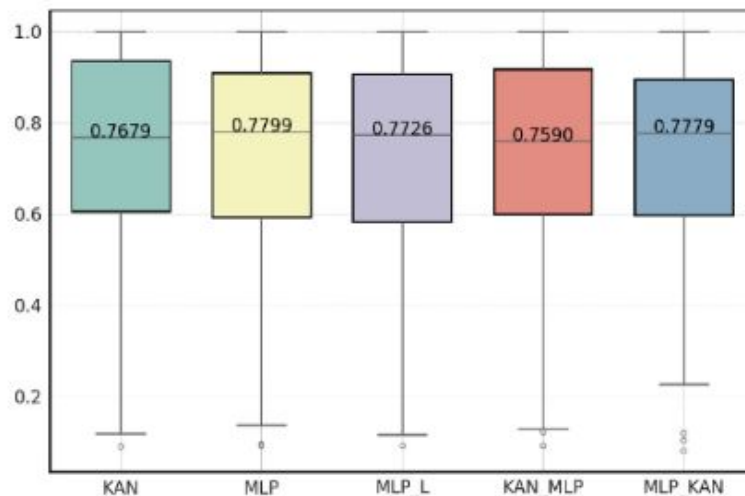
Adapted from the YouTube video "Kolmogorov-Arnold Networks (KANs) – What are they and how do they work?", at timestamp 2:07.

Related Work (KAN for TSC)

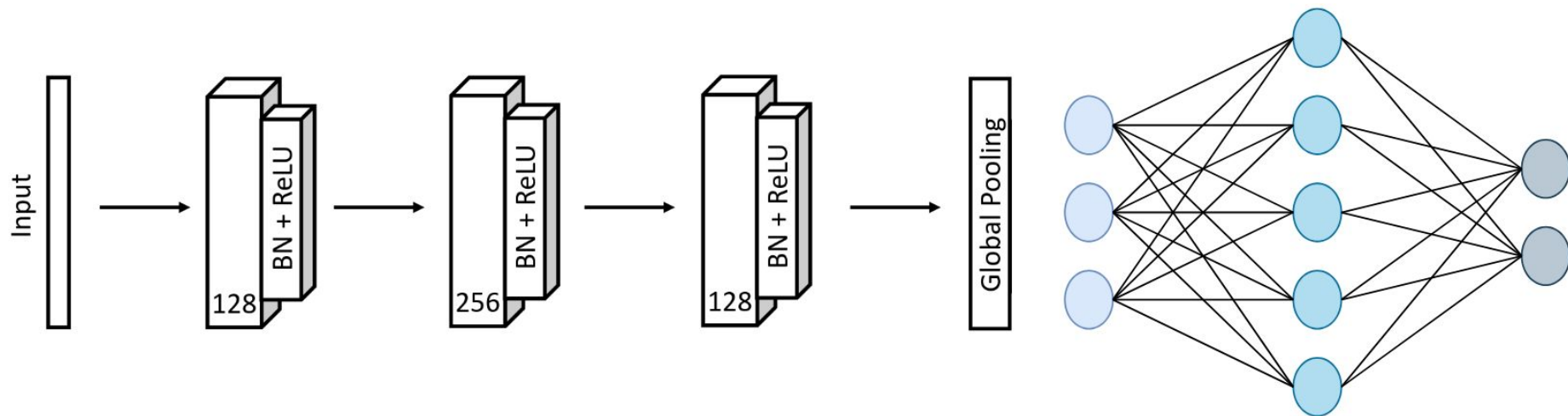Recent studies [1] show that MLP and KANs have similar performance.

(a) Test Accuracy of five models

(b) Test F1 Score of five models

[1] Dong, C., Zheng, L., Chen, W.: Kolmogorov-Arnold Networks (KAN) for time series classification and robust analysis. In: International Conference on Advanced Data Mining and Applications, pp. 342–355. Springer (2024)

Fully Convolutional Network (FCN)

Adapted from: Wang, Z., Yan, W., Oates, T.: Time series classification from scratch with deep neural networks: a strong baseline.
In: 2017 International Joint Conference on Neural Networks (IJCNN), pp. 1578–1585. IEEE (2017)

FCKAN
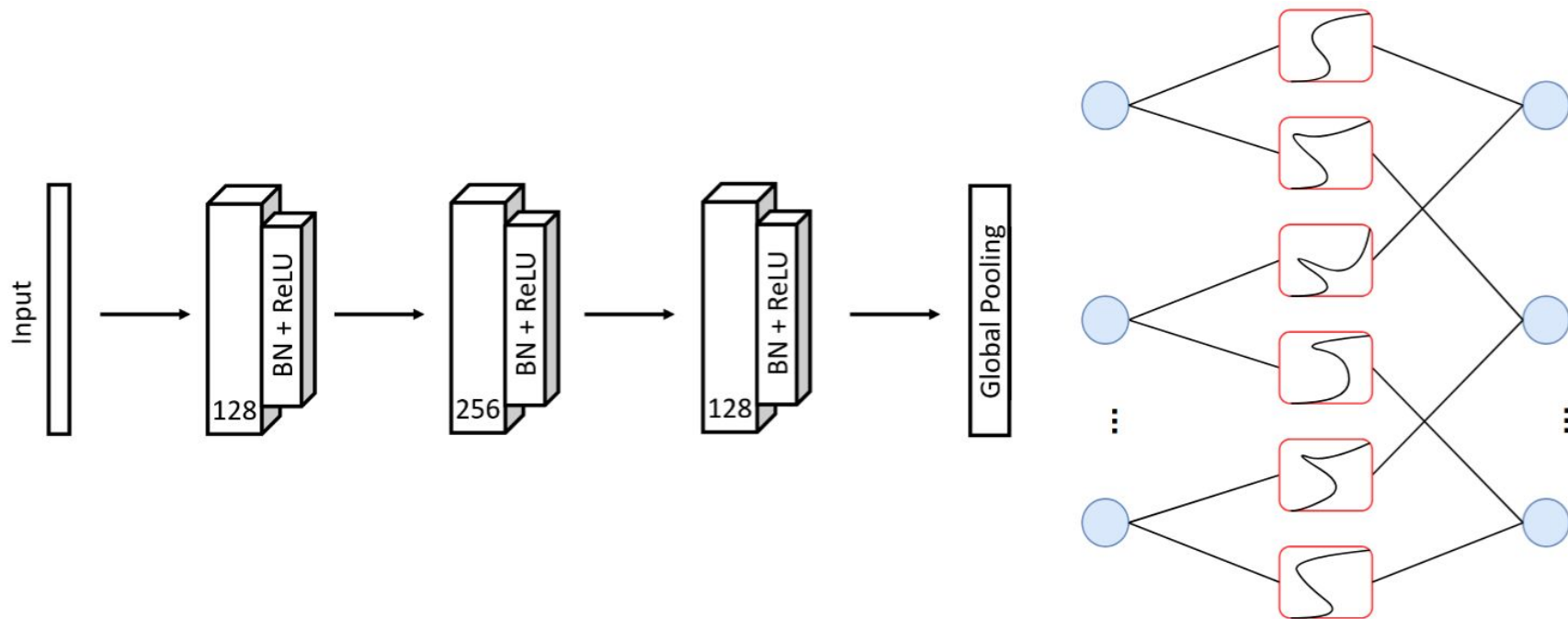
Hybrid FCN-KAN ❄️

Frozen ❄️
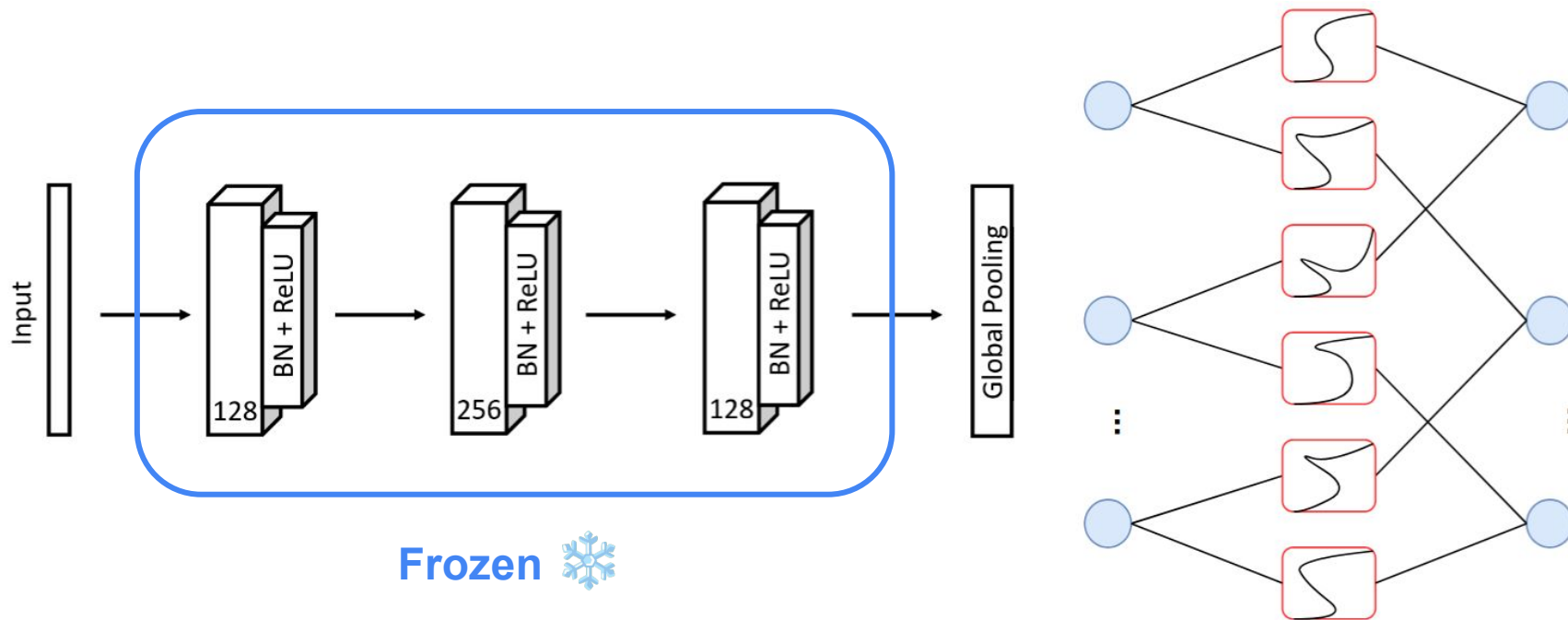
Experimental Setup

Task	Dataset
TSC	UEA Multivariate Time Series Classification Archive (128)
TSER	Monash University, UEA, UCR Time Series Extrinsic Regression Archive (19)

Experimental Setup

Model	Number of epochs	Early Stopping
MLP	100	10 epochs
KAN	100	10 epochs
FCN	2000	50 epochs
Hybrid FCN-KAN ❄️	100	10 epochs
FCKAN	2000	50 epochs

Experimental Results (TSC)

Critical Difference Diagram - Nemenyi post hoc
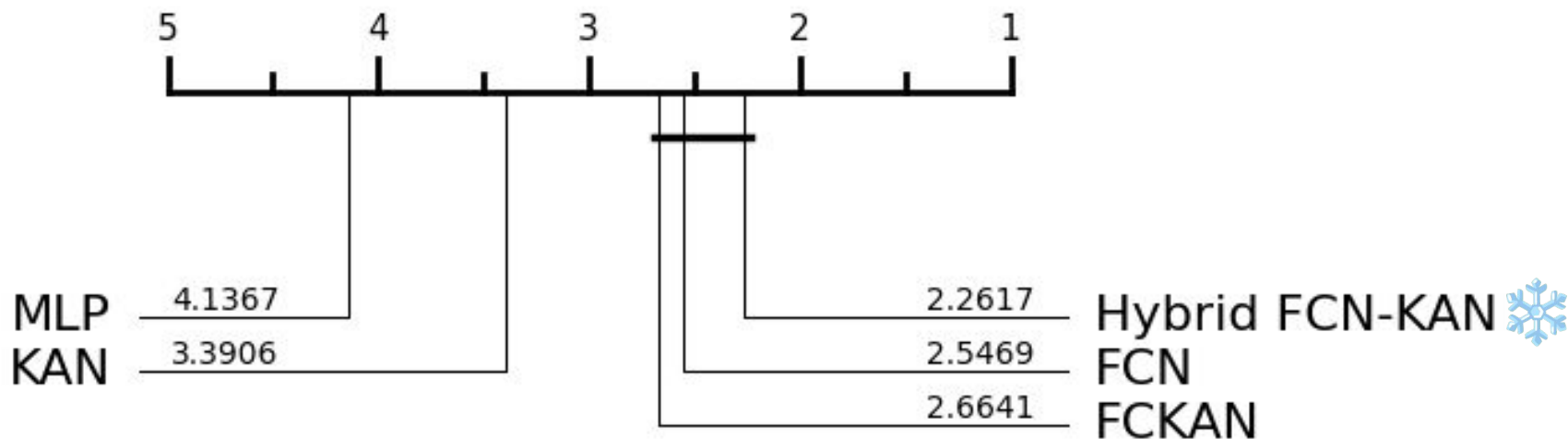
Experimental Results (TSC)

Pairwise Win/Tie/Loss counts

	MLP	KAN	FCN	Hybrid FCN-KAN	FCKAN
MLP	-	49/2/77	28/2/98	24/5/99	38/1/89
KAN	-	-	46/4/78	42/4/82	51/2/75
FCN	-	-	-	56/10/62	70/4/54
Hybrid FCN-KAN	-	-	-	-	70/4/54
FCKAN	-	-	-	-	-

Experimental Results (TSER)

Critical Difference Diagram - Nemenyi post hoc
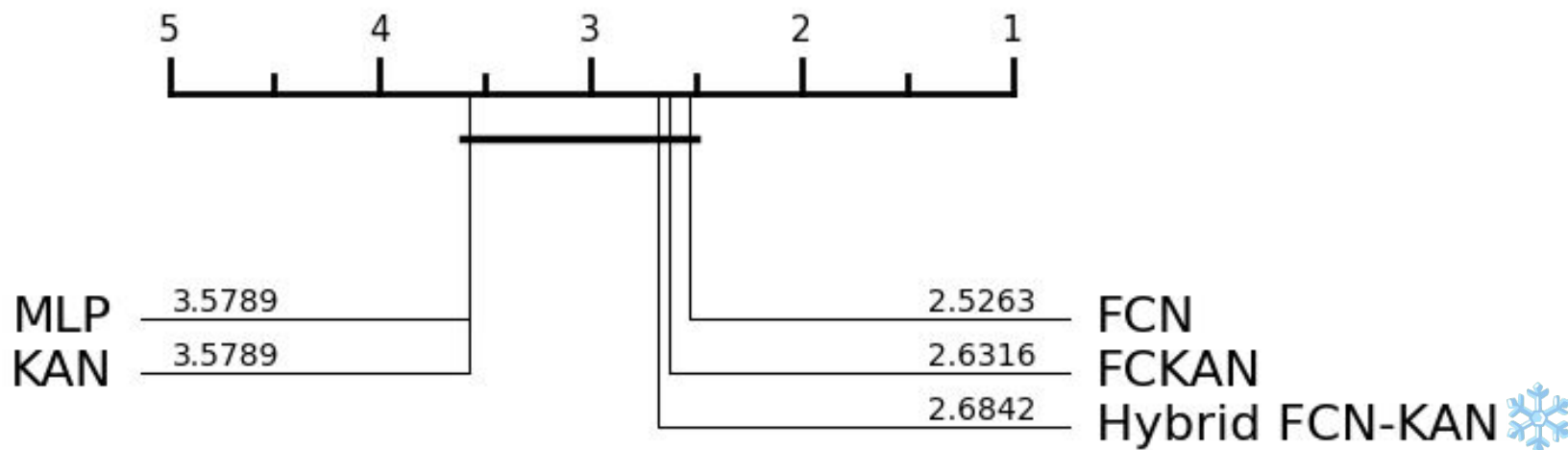
Experimental Results (TSER)

Pairwise Win/Tie/Loss counts

	MLP	KAN	FCN	Hybrid FCN-KAN	FCKAN
MLP	-	10/0/9	6/0/13	7/0/12	4/0/15
KAN	-	-	5/0/14	5/0/14	8/0/11
FCN	-	-	-	10/0/9	10/0/9
Hybrid FCN-KAN	-	-	-	-	9/0/10
FCKAN	-	-	-	-	-

Conclusion

- KANs are effective for TSER, achieving performance comparable to MLPs

- Temporal feature extraction is key: temporal models outperform non-temporal baselines in both TSC and TSER

- Observed gradient propagation issues during end-to-end FCKAN training

Thanks!

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