

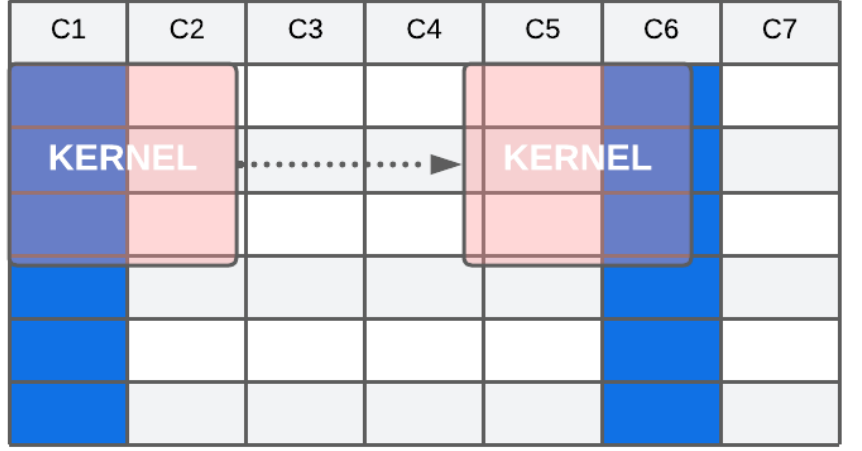
1 Motivation

- **Synthetic data** is the key to **privacy** in industrial **data sharing** as regulated by GDPR.
- State-of-the-art tabular data synthesizer CTAB-GAN [1] **fails** at mimicking **global relations**, and depends on **column order**.
- The **Fourier Neural Operator (FNO)** [2] can capture **global** information in **Fourier space**.

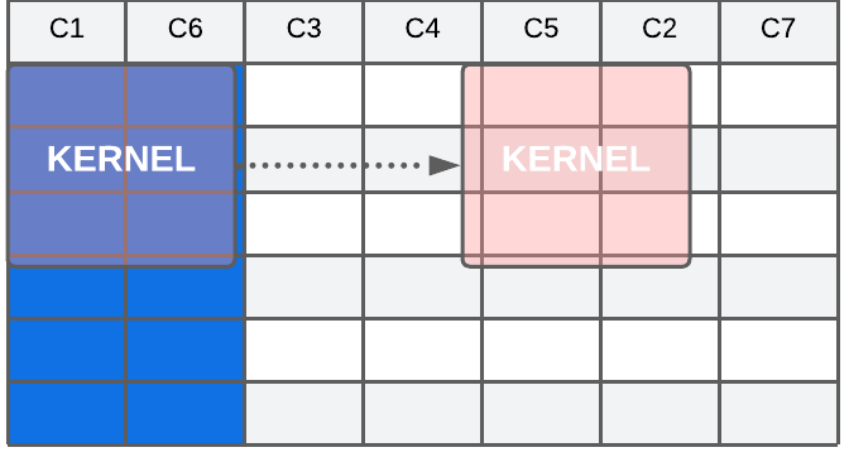
How can the FNO improve global relation resemblance in tabular data synthesis?

2 State-of-the-art limitations

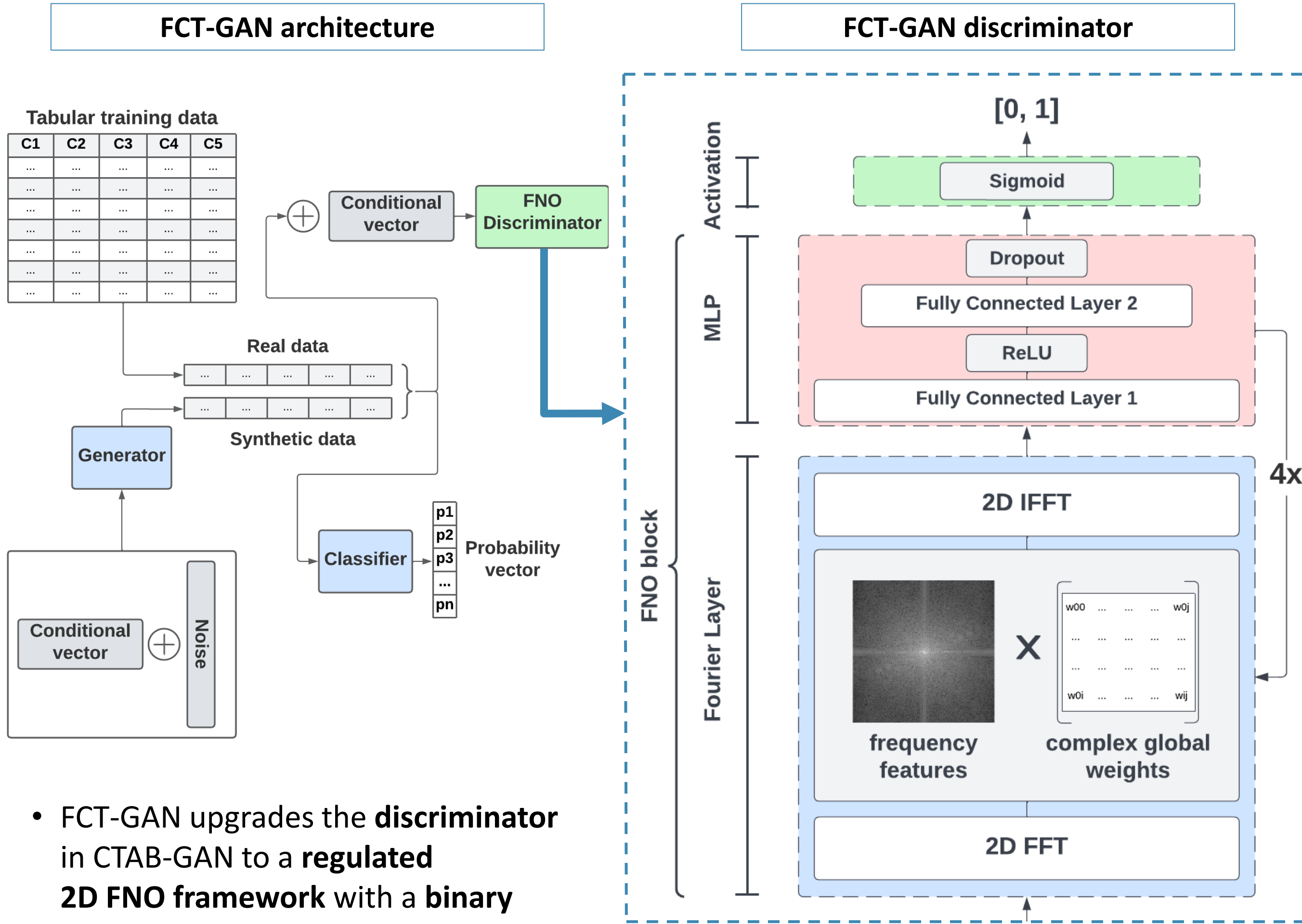
- The Convolutional Neural Network's **kernel** in CTAB-GAN cannot capture **dependencies** between **distant columns**.



- **Permutations** influence CTAB-GAN's results → CTAB-GAN is **column order dependent**.



3 Method: FCT-GAN



FCT-GAN architecture

FCT-GAN discriminator

- FCT-GAN upgrades the **discriminator** in CTAB-GAN to a **regulated 2D FNO framework** with a **binary discrimination** adaptation.
- Sequential chaining of four FNO blocks performing **Fourier manipulations**, and latent space **size reductions**.
- Intercalation of **random dropouts** and **2D batch normalizations** to prevent over-fitting.
- **Sigmoid** binary discrimination on reduced latent space.

4 Results against state-of-the-art

FCT-GAN **outperforms** CTAB-GAN in **ML-utility** (except F1-score) and **statistical similarity**.

Method	ML Utility difference			Statistical Similarity		
	Acc.	F1	AUC	Avg JSD	Avg WD	Corr. Dif.
FCT-GAN	7.46%	0.243	0.141	0.031	581	2.06
CTAB-GAN	10.59%	0.184	0.147	0.074	1344	2.39

FCT-GAN is more **robust** against **column permutations** than CTAB-GAN.

Method	ML Utility difference			Statistical Similarity		
	Acc.	F1	AUC	Avg JSD	Avg WD	Corr. Dif.
FCT-GAN	0.520%	0.041	0.037	0.003	0.031	0.032
CTAB-GAN	2.351%	0.040	0.125	0.010	466.093	0.111

5 Conclusion

1. FCT-GAN is the **first FNO-enhanced** tabular data synthesizer.
2. It integrates a regulated **2D FNO** into CTAB-GAN's discriminator.
3. It outperforms the state-of-the-art by improving **global dependency** resemblance.
4. It is robust to **column order**.

6 References

1. Zilong Zhao, Aditya Kunar, Hiek Van der Scheer, Robert Birke, and Lydia Y. Chen. Ctab-gan: Effective table data synthesizing, 2021.
2. Zongyi Li, Nikola Kovachki, Kamyar Azizzadenesheli, Burigede Liu, Kaushik Bhattacharya, Andrew Stuart, and Anima Anandkumar. Fourier neural operator for parametric partial differential equations, 2020.