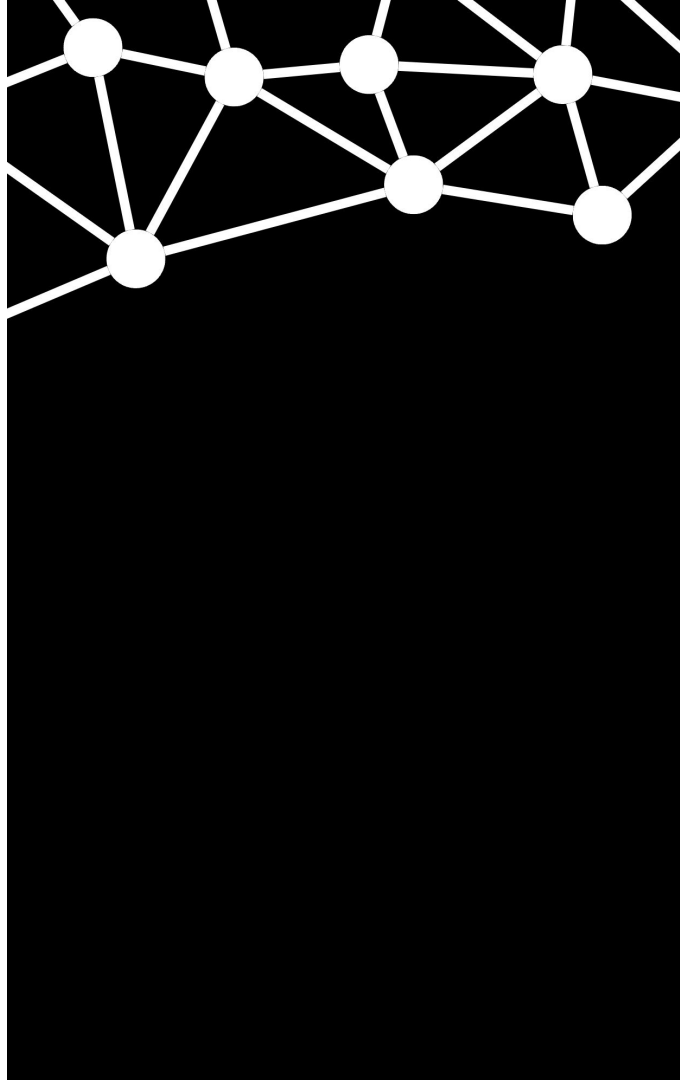


TIM LMS

27/02/2025

Vitor Fontana Zanotelli



Causal study

- Cellular QoE Prediction for Video Service Based on Causal Structure Learning
 - 10.1109/TITS.2022.3167685
 - With the development of telecommunication technology and the popularity of intelligent devices, user experience in cellular network has become the primary factor of concern. At the same time, network operators are plagued by two problems: Prediction of users real-time experience and find network parameters that have a decisive impact on user experience. We proposed a novel scheme for user experience prediction to deal with these two problems. Causal structure learning for cellular networks was used to analyze numerous performance indicators (KPIs) collected from base stations and key quality indicators (KQIs). Through causal structure learning, a directed causal graph based on the association between KPIs and KQI can be obtained. This causal structure can be embedded in graph attention network. Among them, attention mechanism was selected to further strengthen the correlation between parameters. This correlation between each KPI and between KPIs and KQI was used to predict future value of cell level user experience. Results showed that proposed method performance well in cellular network data analysis and user experience prediction.

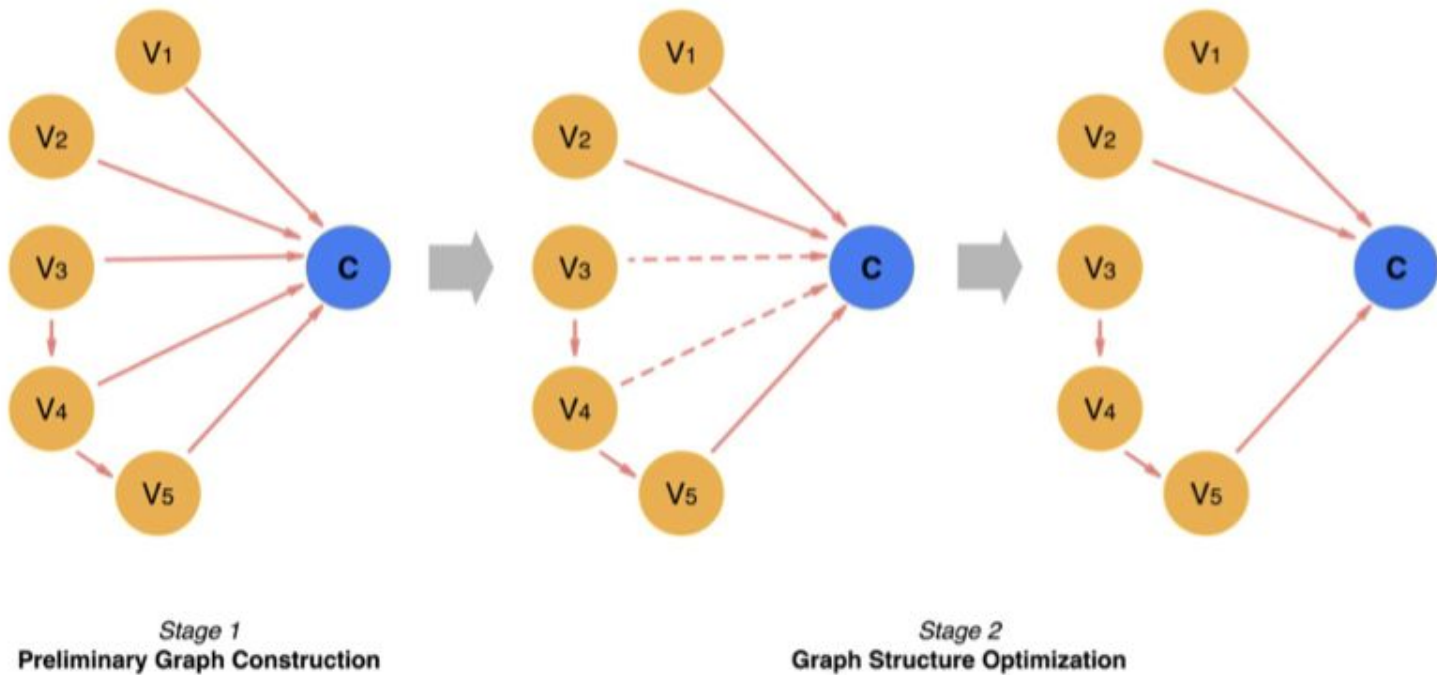
Causal study

- Transfer entropy from a process **X** to another process **Y** is the amount of uncertainty reduced in future values of **Y** by knowing the past values of **X** given past values of **Y**

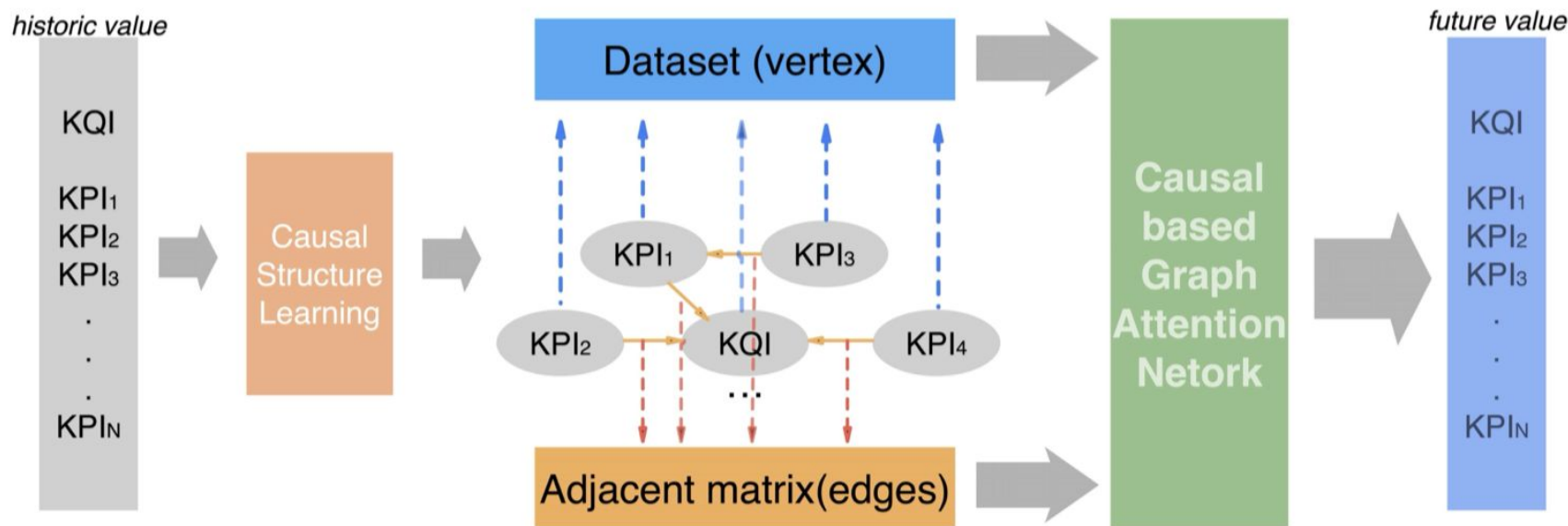
$$\frac{T_{V_i \rightarrow V_j}}{T_{V_j \rightarrow V_i}} = \begin{cases} true \geq 1 \\ false < 1 \end{cases}$$

- If true **V_i** causes **V_j**

Causal Graph Structure



Causal Structure Acquisition

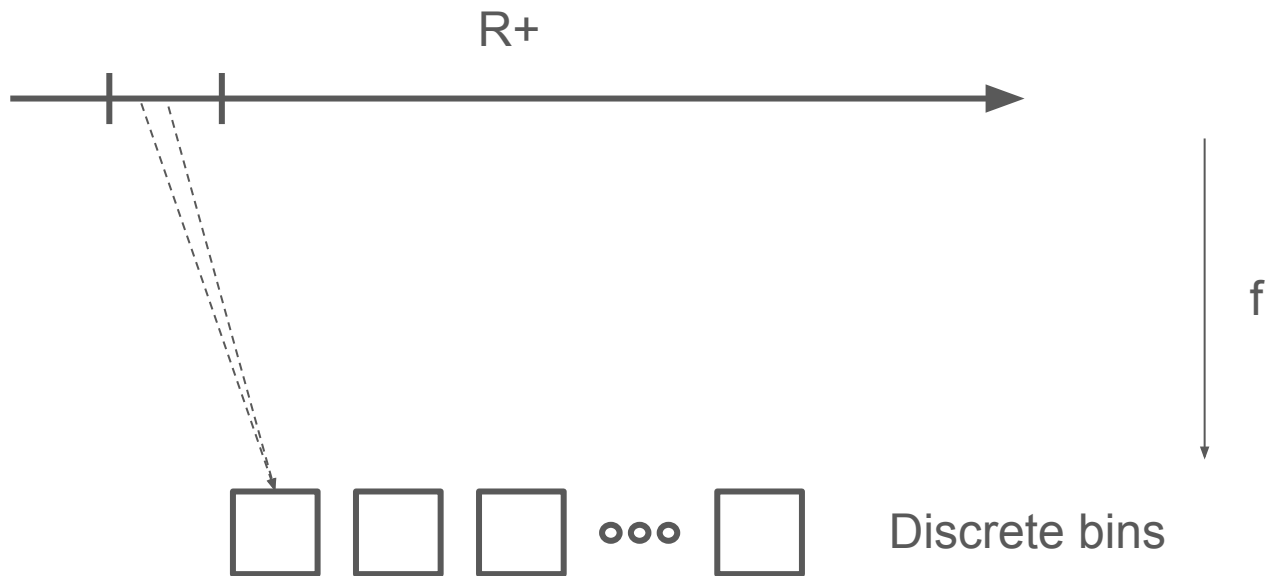


Data Discretization

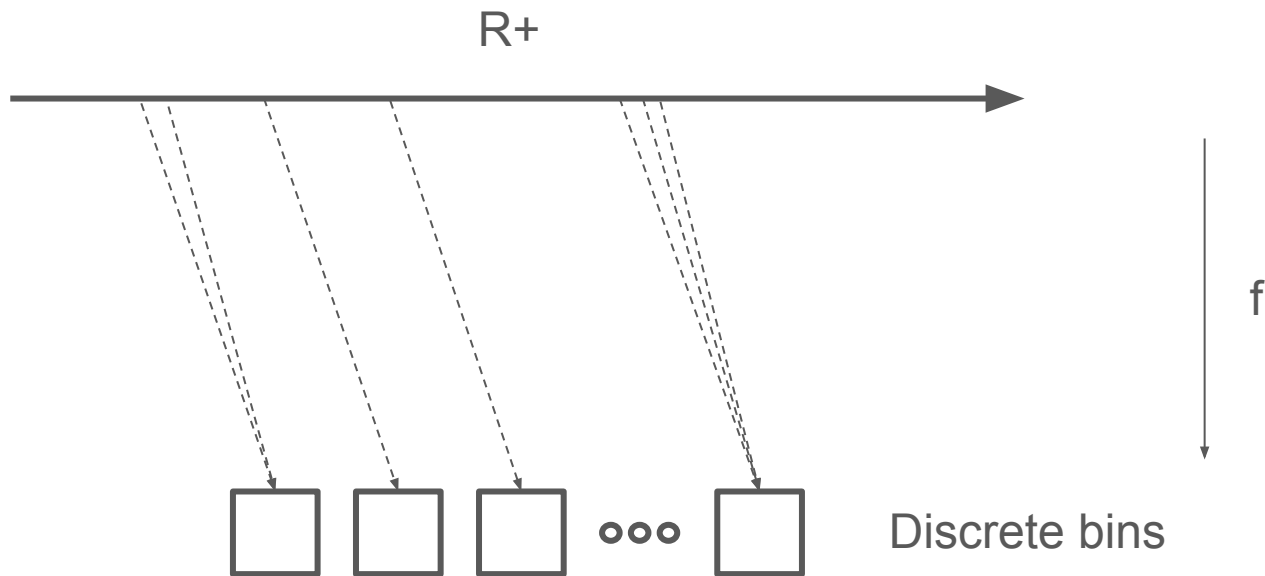


Discrete bins

Data Discretization



Data Discretization

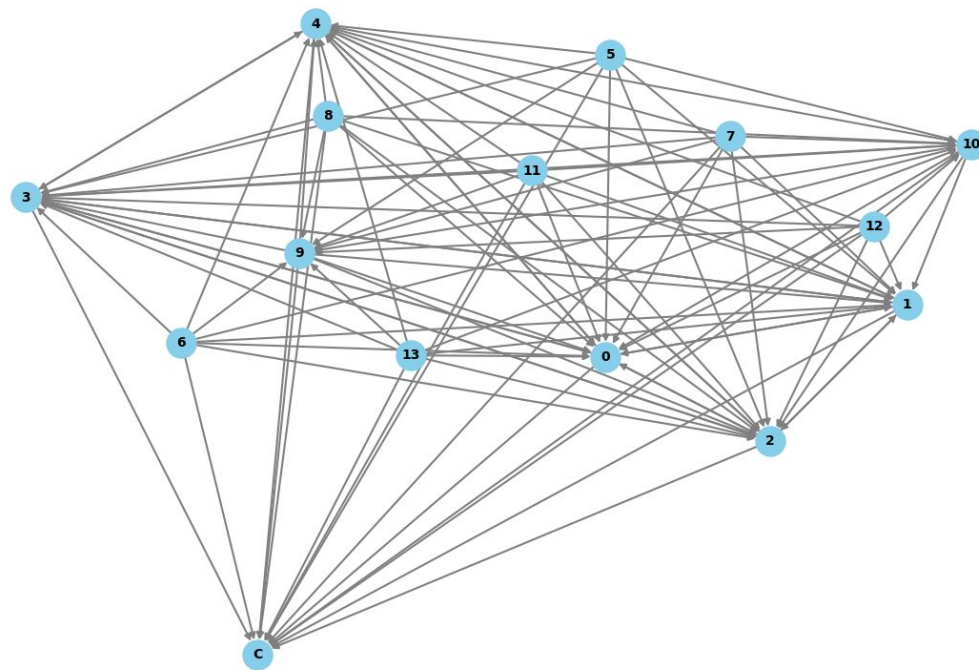


Causal Graph

- In **stage 1**, any two nodes with causality will be given a directed edge according to the calculation of transfer entropy.
- In **stage 2**, the relationship between all nodes has been determined.
 - We optimize the causal structure between multiple nodes. This simplification is not only for the convenience of later operation, but also the connection with the strongest causality is retained.
 - It is worth noting that the optimization of causality structure in stage 2 makes the causality diagram appear in the form of tree diagram. In the tree diagram, the root node is Y , and other vertices represent different X s.

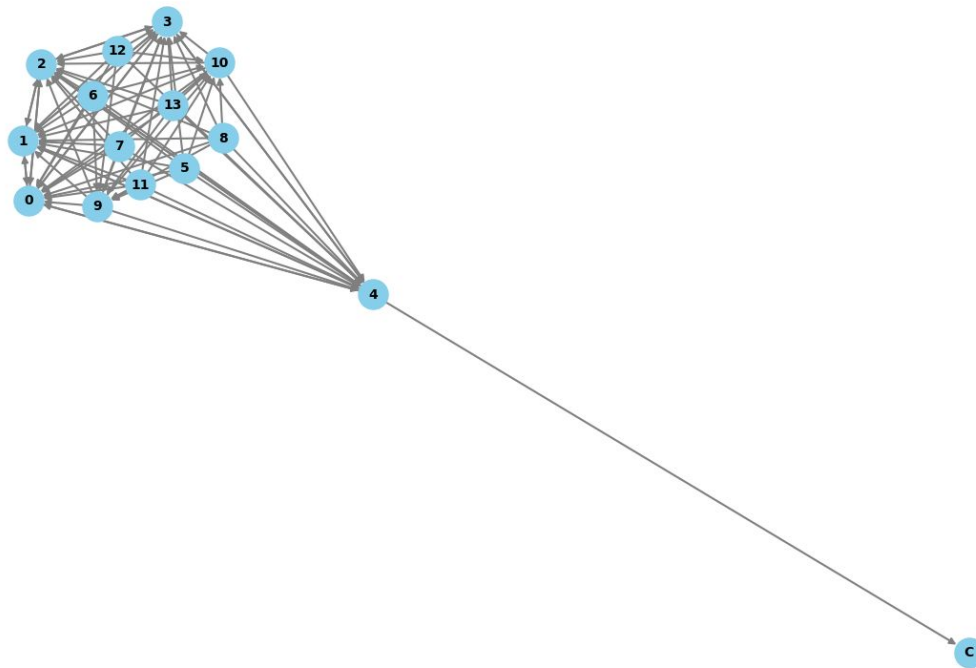
Stage 1

Grafo de Causalidade



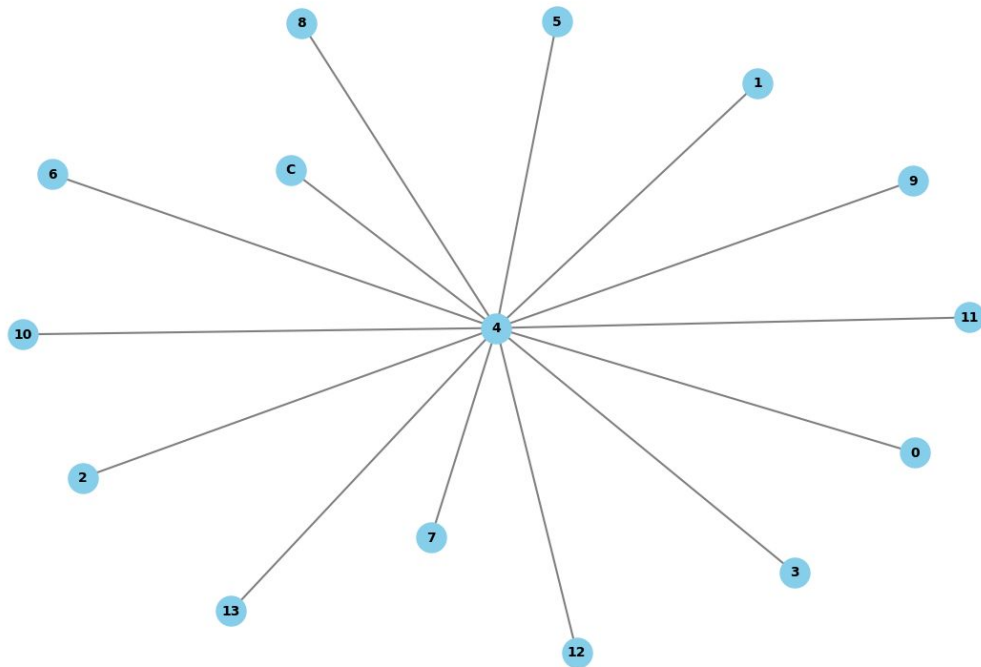
Stage 2

Grafo de Causalidade



Stage 3

Grafo de Causalidade



Debugging

- Features constantes apresentando relação causal
 - Se é constante a informação de uma série não deveria influenciar na predição de outra
- Causalidade calculada retornando o mesmo valor em mais de um caso
- Variando tamanho de número de bins e janelas

Obrigado!

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