

Monthly Research Progress

April 2025

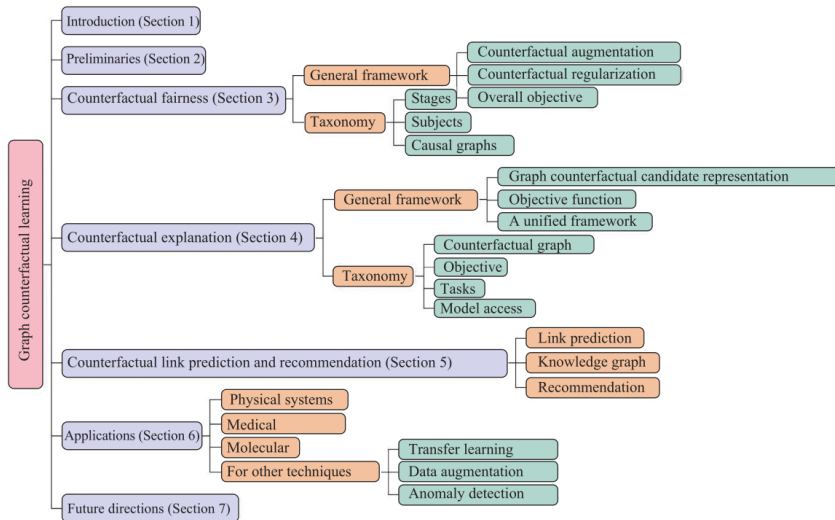
Nithish Kumar V

Department of Computer Science and Engineering
Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram

April 19, 2025

1. Organization of the Survey Paper
2. Counterfactual Fairness
3. Counterfactual Learning
4. Counterfactual Learning on Graphs

Organization of the Survey Paper



Sources of Bias

- The biases in the data lead to unfair predictions
- Various sources of bias in any i.i.d (independent and identically distributed data)
 1. Historical Bias
 2. Representation Bias
 3. Temporal Bias
 4. Attribute Bias
- Source of Bias specific to graph data
 1. Linking Bias
 2. Structural Bias

Counterfactual Fairness

- Biases are measured from different perspectives.
 1. Group fairness
 2. Individual fairness
- The above metrics rely on the statistical correlation among variables, which may not describe the intrinsic causal structure
- Inspired by the development of counterfactual learning, counterfactual fairness is proposed as a notion to measure fairness from the perspective of causal inference

Definition

Counterfactual fairness makes the outputs of a machine learning model for an individual in the actual world remain the same when we flip the sensitive attribute of the same individual to the counterfactual world.

Heading

1. Statement
2. Explanation
3. Example

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Integer lectus nisl, ultricies in feugiat rutrum, porttitor sit amet augue. Aliquam ut tortor mauris. Sed volutpat ante purus, quis accumsan dolor.

Counterfactual Learning

- Counterfactual learning gives a chance to alleviate the intrinsic bias making models interpretable and exploiting the information stored in data well
- Counterfactual comes from the research community of causal inference.
- 2 main concepts
 1. Counterfactual Fairness: prediction for an individual is fair if it remains the same in a counterfactual world where the individual belongs to a different demographic group
 2. Counterfactual Explanation
- Besides the aid on fairness and interpretability, the research community also utilizes counterfactual learning to provide additional information from the counterfactual world [Guo et al., 2025]

Counterfactual Learning cont..

- Compared with traditional statistical models, causal models have better generalization ability in modeling real-world systems

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table: Table caption

Theorem

Theorem (Mass–energy equivalence)

$$E = mc^2$$

Figure


Uncomment the code on this slide to include your own image from the same directory as the template .TeX file.

Counterfactual Learning on Graphs

- Recent works on graph counterfactual learning have shown great potential to overcome the aforementioned challenges on fairness, explanation, etc.

An example of the `\cite` command to cite within the presentation:

This statement requires citation [Guo et al., 2025].

-  Guo, Z., Wu, Z., Xiao, T., Aggarwal, C., Liu, H., and Wang, S. (2025).
Counterfactual learning on graphs: A survey.
Machine Intelligence Research, 22(1):17–59.

The End