

Causality (Part 1)

Fourth week of machine learning workshop

Outline

- Introduction to causality
 - Some motivating examples about why causality matters
 - Ladder of causation
 - Association \rightarrow Correlation
 - Intervention \rightarrow Causation
 - Imagination \rightarrow Counterfactual
 - How causality and machine learning complement each other
 - When using causal inference (when we want to control and intervene) and when using machine learning (for prediction, passive behavior)
- Observational vs interventional distribution
 - What is causal query
 - Introducing 'do' notation
 - Why conditional distribution is different from interventional distribution
- Randomized controlled trials
 - By randomized controlled trials we can estimate the causal query by data in the trials.
 - Randomized controlled trials in drug discovery and A/B testing.
- Prior knowledge (causal graph)
 - How to estimate causal query when randomized controlled trial is not possible? How to estimate causal query from observational distribution?
 - We need to add prior knowledge (causal graph) in order to answer causal query

- Data + prior knowledge (causal graph) \rightarrow causal query estimation
- Do-calculus
- Confounder
 - Simpson paradox
 - Kidney stone example for introducing confounder
 - How to make policy in presence of confounder

References

1. Causality: Models, Reasoning and Inference Hardcover – September 14, 2009. Second edition. by Judea Pearl
2. The Book of Why: The New Science of Cause and Effect. Book by Dana Mackenzie and Judea Pearl. 2018
3. Elements of Causal Inference: Foundations and Learning Algorithms. Book by Bernhard Schölkopf, Dominik Janzing, and Jonas Peters. MIT press. 2017