

# DBA4712: Causal Analytics for Managerial Decisions

NUS Business School      Department of Analytics & Operations (DAO)

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## Administrative Information

- Instructor: Bin HUANG
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- Instructor: Long ZHAO
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- Prerequisite: DAO2702 & DAO3803
- Evaluation:
  - Individual Assignments: 20%
  - Two Projects: 20% + 20%
  - Two Quizzes: 15% + 15%
  - Class Participation: 10%
- Coding: R or Python

## Course Outline and Schedule

We often use machine learning to find the association of two events, such as: the frequency to the hospital is strongly negatively correlated with life expectancy; or the number of bedrooms strongly positively correlates with HDB price. Such strong associations might lead to non-sensible decisions like not seeing a doctor when getting sick or building a wall to create a new bedroom. Other than the warning “correlation is not causation,” can we have a systematic way to disentangle correlation from causation?

This course will enable you to apply causal analysis to a wide range of problems, such as why the experts are confident that the COVID vaccine is effective, what business policy boosts the economy, and which ad recommendation algorithm generates higher revenue. Based on such solid causal relationships, one could make sensible life and business decisions.

| Week | Date      | Topic                                   | Remark           |
|------|-----------|---|------------------|
| 1    | Aug. 12th | Introduction to Causal Analytics        | -                |
| 2    | Aug. 19th | Potential Outcome                       |                  |
| 3    | Aug. 26th | Random Controlled Experiments           |                  |
| 4    | Sep. 2nd  | A/B Test                                | Assignment 1 Due |
| 5    | Sep. 9th  | Multi-Armed Bandit                      | In-class Quiz 1  |
| 6    | Sep. 16th | Project 1                               |                  |
| -    | Sep. 25th | Recess Week                             |                  |
| 7    | Oct. 1st  | Machine Learning in Causality           | Project 1 Due    |
| 8    | Oct. 7th  | Matching                                |                  |
| 9    | Oct. 14th | Event & Regression Discontinuity Design |                  |
| 10   | Oct. 21st | Instrumental variable                   |                  |
| 11   | Oct. 28th | Difference in differences               | Assignment 2 Due |
| 12   | Nov. 4th  | No Class Because of Deepavali           |                  |
| 13   | Nov. 11th | Project 2                               | In-class Quiz 2  |
| -    | Nov. 18th | Reading Week                            | Project 2 Due    |

## Resources

- [Datacamp.com](#): just in case you forgot coding.
  - You should be able to use DataCamp for free with your **NUS email** (domain: @u.nus.edu).
  - If you cannot join it, please let me know ASAP.

### *Optional Videos & Books:*

- [Causal Inference Bootcamp by Matt Masten](#)
  - These videos are well explained and non-technical. Highly recommended.
- [Causal Inference for Statistics, Social and Biomedical Sciences](#).
  - Most theoretical materials come from this book.
- Mostly harmless econometrics: an empiricist’s companion
  - Regression discontinuity design and instrumental variable depends heavily on this book.

## Individual Assignments

Individual assignments help you to prepare for the quizzes. They are a combination of conceptual questions, simple mathematical derivations, and simple coding questions. For example, we might ask you why the claim that certain diet is beneficial for weight loss might be problematic; if  $X$  and  $Y$  are independent and  $E(X) = 3$ ,  $E(Y) = 4$  what is the value of  $E(X|Y)$ ?; construct the 95% confidence interval of the difference in income. Each of them shall take less than 5 hours on average.

## Two Group Projects

We will first introduce each project during class and then provide a brief discussion. We expect all of them are challenging for the following three reasons.

- All have the flavor of open-ended questions. Just copying what I have done in the class will not be enough. You need to think and analyze the problems.
- All have unique characteristics that make it special. That is to say, you need to have a customized approach.
- It is always hard to write code from scratch. Make sure you utilize existing libraries.

## **Two Quizzes**

They will be available on LumiNUS during the class time.

**If you could not attend the class synchronized, please let us know ASAP.**

## **Questions**

For questions regarding course materials, please post on LumiNUS Forum. For questions in emails, I might re-post them and answer them on the Forum. I might also create a FAQ on Google Docs as a more organized approach.

For issues in course administration, please email with the subject “DBA4712+Name”.