# stl2137_p8122_hw1

## Question 1

### Part A

For all individuals calculate the effect of treatment on the outcome and interpret.

| Individual | $Y_0$ | $Y_1$ | $Y_0 - Y_1$ |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 2 | 1 | 0 | 1 |
| 3 | 0 | 1 | -1 |
| 4 | 1 | 0 | 1 |
| 5 | 1 | 0 | 1 |
| 6 | 0 | 1 | -1 |
| 7 | 1 | 0 | 1 |
| 8 | 0 | 0 | 0 |

- For individuals 2, 4, 5, and 7, $Y_0$ had a positive causal effect.
- For individuals 3 and 6, $Y_0$ had a negative causal effect.
- For individuals 1 and 8, neither $Y_0$ or $Y_1$ had a causal effect.

### Part B

Calculate the average causal effect of treatment on the outcome and interpret.

$E[Y_0] - E[Y_1]$

$= \frac{4}{8} - \frac{2}{8} = \frac{1}{4}$

- Treatment 0 is better on average than treatment 1.

### Part C

Calculate the association of the treatment with the outcome under the following treatment assignment for subjects $i = 1, .., 8 : A_1 = 1, A_2 = 0, A_3 = 1, A_4 = 1, A_5 = 0, A_6 = 0, A_7 = 0, A_8 = 1$. Interpret the result, compare with the effect computed in question 1b.

| Individual | $Y_0$ | $Y_1$ | Treatment |
|---|---|---|---|
| 1 | 0 | 0 | $A_1 = 1$ |
| 2 | 1 | 0 | $A_2 = 0$ |
| 3 | 0 | 1 | $A_3 = 1$ |
| 4 | 1 | 0 | $A_4 = 1$ |
| 5 | 1 | 0 | $A_5 = 0$ |
| 6 | 0 | 1 | $A_6 = 0$ |

| Individual | $Y_0$ | $Y_1$ | Treatment |
|---|---|---|---|
| 7 | 1 | 0 | $A_7 = 0$ |
| 8 | 0 | 0 | $A_8 = 1$ |

$E[Y|A = 0] - E[Y|A = 1]$

$= \frac{4}{4} - \frac{2}{4} = \frac{1}{2}$

The difference in observed group means and apparent effects between $Y_0$ and $Y_1$ is $\frac{1}{2}$, which is higher than the ACE of $\frac{1}{4}$ from part 1b. The apparent effect from the difference in observed group mean overstates the causal effect when compared to the ACE.

### Part D

Show a random assignment of the treatment for this population. Explain your work. Compute the association of the treatment with the outcome under the random assignment and compare with the treatment effect computed in question 1b.

```
set.seed(21)
rbinom(8, 1, 0.5)
```

```
## [1] 1 0 1 0 1 1 0 0
```

| Individual | $Y_0$ | $Y_1$ | Treatment |
|---|---|---|---|
| 1 | 0 | 0 | $A_1 = 1$ |
| 2 | 1 | 0 | $A_2 = 0$ |
| 3 | 0 | 1 | $A_3 = 1$ |
| 4 | 1 | 0 | $A_4 = 0$ |
| 5 | 1 | 0 | $A_5 = 1$ |
| 6 | 0 | 1 | $A_6 = 1$ |
| 7 | 1 | 0 | $A_7 = 0$ |
| 8 | 0 | 0 | $A_8 = 0$ |

$E[Y|A = 0] - E[Y|A = 1]$

$= \frac{4}{6} - \frac{2}{2} = -\frac{1}{3}$

The difference in observed group means and apparent effects between $Y_0$ and $Y_1$ is $-\frac{1}{3}$. Unlike in part 1b, where the ACE states that the causal effect is $\frac{1}{4}$, meaning that Treatment 0 is better, this derived apparent effect of $-\frac{1}{3}$ implies that Treatment 1 is better.