

p8122_HW1

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Question 1a

```
individuals = data.frame(  
  Individual = 1:8,  
  Y0 = c(0, 1, 0, 1, 1, 0, 1, 0),  
  Y1 = c(0, 0, 1, 0, 0, 1, 0, 0)  
)  
  
# calculate treatment effects  
individuals = individuals |>  
  mutate(TE = Y1 - Y0) # add a col TE  
  
individuals |>  
  kable()
```

Individual	Y0	Y1	TE
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

Question 1b

```
ACE = individuals |>  
  summarise(ACE = mean(TE)) |>  
  pull(ACE)  
  
cat("The average causal effect (ACE) is:", ACE, "\n")
```

```
## The average causal effect (ACE) is: -0.25
```

Question 1c

```
assigned_treatment = c(1, 0, 1, 1, 0, 0, 0, 1)

individuals = individuals |>
  mutate(Assigned_Treatment = assigned_treatment,
         Observed = ifelse(assigned_treatment == 1, Y1, Y0))

cat("Table: Observed Outcomes under Assigned Treatment\n")
```

Table: Observed Outcomes under Assigned Treatment

```
individuals |>
  select(Individual, Y0, Y1, Assigned_Treatment, Observed) |>
  kable()
```

Individual	Y0	Y1	Assigned_Treatment	Observed
1	0	0	1	0
2	1	0	0	1
3	0	1	1	1
4	1	0	1	0
5	1	0	0	1
6	0	1	0	0
7	1	0	0	1
8	0	0	1	0

```
mean_treatment = individuals |>
  filter(Assigned_Treatment == 1) |>
  summarise(mean_treatment = mean(Observed)) |>
  pull(mean_treatment)

mean_control = individuals |>
  filter(Assigned_Treatment == 0) |>
  summarise(mean_control = mean(Observed)) |>
  pull(mean_control)

association = mean_treatment - mean_control
cat("The association between treatment and outcome under specific treatment assignment is:", association)
```

The association between treatment and outcome under specific treatment assignment is: -0.5

Interpretation:

The association between treatment and outcome under the specific treatment assignment is -0.5, which indicates individuals in the treatment group had worse health status (mean = 0.25) compared to the control group (mean = 0.75).

Question 1d

```

set.seed(329)
random_assignment = sample(c(0, 1), size = 8, replace = TRUE)

individuals = individuals |>
  mutate(Random_Assigned_Treatment = random_assignment,
         Random_Assigned_Observed = ifelse(random_assignment == 1, Y1, Y0))

cat("Table: Observed Outcomes under Random Assignment\n")

```

```
## Table: Observed Outcomes under Random Assignment
```

```

individuals |>
  select(Individual, Y0, Y1, Random_Assigned_Treatment, Random_Assigned_Observed) |>
  kable()

```

Individual	Y0	Y1	Random_Assigned_Treatment	Random_Assigned_Observed
1	0	0	0	0
2	1	0	1	0
3	0	1	0	0
4	1	0	0	1
5	1	0	1	0
6	0	1	0	0
7	1	0	1	0
8	0	0	1	0

```

# Calculate the association for random assignment
mean_treatment_random = individuals |>
  filter(Random_Assigned_Treatment == 1) |>
  summarise(mean_treatment_random = mean(Random_Assigned_Observed)) |>
  pull(mean_treatment_random)

mean_control_random = individuals |>
  filter(Random_Assigned_Treatment == 0) |>
  summarise(mean_control_random = mean(Random_Assigned_Observed)) |>
  pull(mean_control_random)

association_random = mean_treatment_random - mean_control_random
cat("The association between treatment and outcome under random assignment is:", association_random, "\n")

```

```
## The association between treatment and outcome under random assignment is: -0.25
```

```

# Compare with part 1b result (ACE)
cat("The ACE calculated in part 1b is:", ACE, "\n")

```

```
## The ACE calculated in part 1b is: -0.25
```

```
cat("Comparison: Association under random assignment:", association_random, "vs ACE:", ACE, "\n")
```

```
## Comparison: Association under random assignment: -0.25 vs ACE: -0.25
```

Question 2a

The unit is the patient who is being treated for blood pressure management.

Question 2b

The treatment is the dosage of medication: 'High Dose' or 'Low Dose'

Question 2c

In this case, we could define two potential outcomes:

- Y_{high} : Blood pressure could be too high if the patient continues with the high dose of medication.
- Y_{low} : Blood pressure could be perfect (or controlled) under the low dose of medication.

Question 2d

```
outcomes_numeric = data.frame(  
  Treatment = c("High Dose", "Low Dose"),  
  Y_high = c(0, NA),  
  Y_low = c(NA, 1)  
)  
  
# Calculate causal effect:  $Y_{\text{low}} - Y_{\text{high}}$   
causal_effect = outcomes_numeric$Y_low[2] - outcomes_numeric$Y_high[1]  
causal_effect
```

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

Interpretation: Switching to the low dose results in better control of blood pressure.

Question 2e

SUTVA is plausible in this scenario: * No interference: The patient's outcome is not influenced by others' treatment. * Consistency: The low dose consistently results in better blood pressure control.

Question 2f

- SUTVA must be plausible to ensure that the potential outcome framework is valid.
- This ensures that the treatment's effect is not influenced by other external factors and the outcome is consistent across treatments.

Question 2g

- Probabilistic: No, the assignment is deterministic based on blood pressure readings.
- Individualistic: Yes, the treatment is specifically tailored for this patient.
- Unconfounded: Yes, treatment is based directly on the observed blood pressure levels, minimizing confounding.
- Controlled: Yes, the physician adjusts the dosage in a controlled manner based on the outcome.

Question 2h

```
set.seed(123)

random_assignment = sample(c("High Dose", "Low Dose"), size = 1, replace = TRUE)
cat("Random Assignment: The patient is assigned to:", random_assignment, "\n")

## Random Assignment: The patient is assigned to: High Dose

random_outcome = ifelse(random_assignment == "High Dose", "Too High", "Perfect")
cat("Observed outcome under random assignment:", random_outcome, "\n")

## Observed outcome under random assignment: Too High

n = 10 # Number of random assignments
results = data.frame(Trial = 1:n, Assigned_Treatment = NA, Outcome = NA)

for (i in 1:n) {
  assigned_treatment = sample(c("High Dose", "Low Dose"), size = 1, replace = TRUE)
  observed_outcome = ifelse(assigned_treatment == "High Dose", "Too High", "Perfect")
  results$Assigned_Treatment[i] = assigned_treatment
  results$Outcome[i] = observed_outcome
}

cat("\nTable: Outcomes under repeated random assignment\n")

##
## Table: Outcomes under repeated random assignment

print(results)
```

```
##      Trial Assigned_Treatment Outcome
## 1      1      High Dose Too High
## 2      2      High Dose Too High
## 3      3      Low Dose  Perfect
## 4      4      High Dose Too High
## 5      5      Low Dose  Perfect
## 6      6      Low Dose  Perfect
## 7      7      Low Dose  Perfect
## 8      8      High Dose Too High
## 9      9      High Dose Too High
## 10     10      Low Dose  Perfect
```