CSC384 A4

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Question 3

Part 1: Separated but not sufficient
Here is the example when separation holds but not sufficiency.
Let C = Diabetes, Y = Hyperlipidemia, A = Gender.
Then we have $P(C|Y, A) = P(C|Y)$ and $P(Y|C, A) \neq P(Y|C)$
To be more specific, for example, $P(Diabetes = YES|Hyperlipidemia = YES, Gender = Male) = P(Diabetes = YES|Hyperlipidemia = YES)$ but $P(Hyperlipidemia = YES|Diabetes = YES, Gender = Male) \neq P(Hyperlipidemia = YES|Diabetes = YES)$.
Here is the Table printed by Python code:

```
db: YES, gd: Male, hl: YES| 0.1494073028184638
db: YES, gd: Male, hl: NO| 0.11316005391439124
db: YES, gd: Female, hl: YES| 0.11225172138199822
db: YES, gd: Female, hl: NO| 0.11590888113498378
db: NO, gd: Male, hl: YES| 0.08189405838453621
db: NO, gd: Male, hl: NO| 0.18072983674360876
db: NO, gd: Female, hl: YES| 0.06152811041500182
db: NO, gd: Female, hl: NO| 0.1851200352070163
```

Diabetes	Gender	Hyperlipidemia	P(db, gd, hl)
YES	Male	YES	0.14941
YES	Male	NO	0.11316
YES	Female	YES	0.11225
YES	Female	NO	0.11591
NO	Male	YES	0.08189
NO	Male	NO	0.18073
NO	Female	YES	0.06153
NO	Female	NO	0.18512

Figure 1: Table of joint probability with respect to Diabetes, Gender and Hyperlipidemia (rounded and cleaner version). Conditional independence relations can be verified by this table.

Part2: Not Separated but sufficient
Here is the example when sufficiency holds but not separation
Let C = Hyperlipidemia, A = Gender, Y = CentralObesity.
Then we have $P(C|Y,A) \neq P(C|Y)$ and $P(Y|C,A) = P(Y|C)$
To be more specific, $P(Hyperlipidemia = NO|CentralObesity = NO, Gender = Female) \neq P(Hyperlipidemia = NO|CentralObesity = NO)$ but $P(CentralObesity = NO|Hyperlipidemia = NO, Gender = Female) = P(CentralObesity = NO|Hyperlipidemia = NO)$
Here is the Table printed by Python code

```
co: YES, gd: Male, hl: YES| 0.182194769076
co: YES, gd: Male, hl: NO| 0.17139766893600003
co: YES, gd: Female, hl: YES| 0.13688538692400004
co: YES, gd: Female, hl: NO| 0.17556117506400004
co: NO, gd: Male, hl: YES| 0.04910659212699999
co: NO, gd: Male, hl: NO| 0.122492221722
co: NO, gd: Female, hl: YES| 0.036894444873000004
co: NO, gd: Female, hl: NO| 0.12546774127800003
```

CentralObesity	Gender	Hyperlipidemia	P(co, gd, hl)
YES	Male	YES	0.18219
YES	Male	NO	0.17140
YES	Female	YES	0.13689
YES	Female	NO	0.17556
NO	Male	YES	0.04911
NO	Male	NO	0.12249
NO	Female	YES	0.03689
NO	Female	NO	0.12547

Figure 2: Table of joint probability with respect to CentralObesity, Gender and Hyperlipidemia. (rounded and cleaner version). Conditional independence relations can be verified by this table.