Sufficiency: A independent of Y given C

Separation: A independent of C given Y.

Example one: sufficiency not holds, separation holds:

Let A be Diabetes, Y be Hyperlipidemia, C be Gender

```
P(Diabetes = YES | Hyperlipidemia = YES, Gender = Female) = 64.6

P(Diabetes = NO | Hyperlipidemia = YES, Gender = Female) = 35.4

P(Diabetes = YES | Hyperlipidemia = YES) = 64.6

P(Diabetes = NO | Hyperlipidemia = YES) = 35.4
```

```
P(Diabetes = YES | Gender = Female, Hyperlipidemia = YES) = 64.6

P(Diabetes = NO | Gender = Female, Hyperlipidemia = YES) = 35.4

P(Diabetes = YES | Gender = Female) = 48.1

P(Diabetes = NO | Gender = Female) = 51.9
```

from the first diagram, we know that Separation holds

Since $P(\text{Diabetes} \mid \text{Hyperlipidemia}, \text{Gender}) = P(\text{Diabetes} \mid \text{Hyperlipidemia})$ for all values in domain of P(Diabetes)

from the second diagram Sufficiency not holds

Since $P(\text{Diabetes} \mid \text{Gender}) \neq P(\text{Diabetes} \mid \text{Gender}, \text{Hyperlipidemia})$

Example 2: Sufficiency holds, Separation holds.

Let a be Gender, Y be Vegetables, C be Hyperlipidemia.

```
P(Gender = Male | Hyperlipidemia = YES, Vegetables = <400g/d) = 57.1

P(Gender = Female | Hyperlipidemia = YES, Vegetables = <400g/d) = 42.9

P(Gender = Male | Hyperlipidemia = YES) = 57.1

P(Gender = Female | Hyperlipidemia = YES) = 42.9
```

```
P(Gender = Male | Vegetables = <400g/d, Hyperlipidemia = YES) = 57.1

P(Gender = Female | Vegetables = <400g/d, Hyperlipidemia = YES) = 42.9

P(Gender = Male | Vegetables = <400g/d) = 53.9

P(Gender = Female | Vegetables = <400g/d) = 46.1
```

from the first diagram, we know that sufficiency holds. since

$P(\text{Gender} \mid \text{Hyperlipidemia}, \text{vegetables}) = P(\text{Gender} \mid \text{Hyperlipidemia})$

from the second diagram, we know the separation not holds

Since $P(\text{Gender} \mid \text{vegetables}, \text{Hyperlipidemia}) \neq P(\text{Gender} \mid \text{Vegetables})$