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# Q1 D-Separation

1. d-sep(B,D / A)

X1 = B

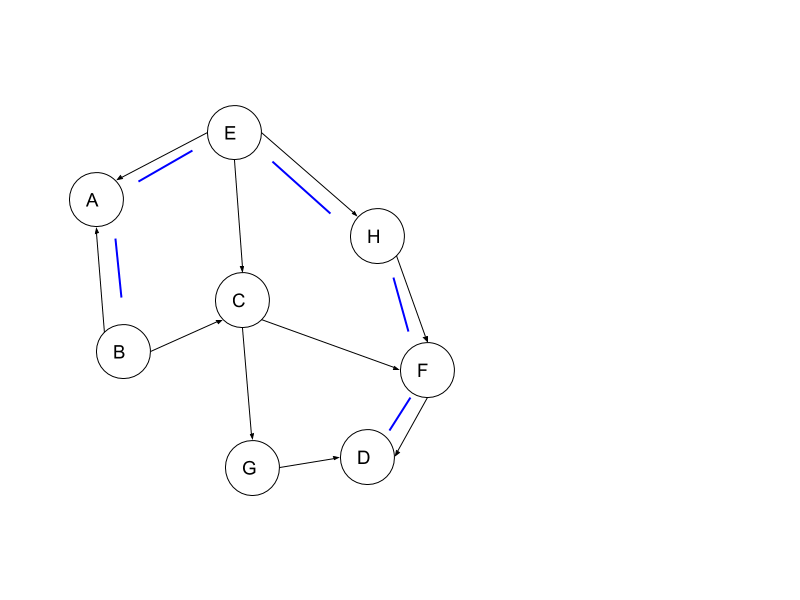
X3 = D

X2 = A

B A E H F D

* A is converging connection and it is in X2 ; therefore doesn’t block information
* E is diverging connection and it is not in X2 ; therefore doesn’t block information
* H is serial connection and it is not in X2 ; therefore doesn’t block information
* F is serial connection and it is not in X2 ; therefore doesn’t block information
* Therefore, for this given path, B and D are not-separated given A.

(According to blue path shown in figure)



There are also other paths present which is also not blocking information.

B A E C F D

B A E C G D

B C G D

Conclusion: B and D are not d-separated given {A}.

1. d-sep(A,D / {C,H})

X1 = A

X3 = D

X2 = {C,H}

A E H F D

* E is diverging connection and it is not in X2 ; therefore doesn’t block information
* H is serial connection and in X2 ; therefore does block information
* Therefore, A and D are separated by this path.

Consider this alternative path:

A E C F D

* E is diverging connection and it is not in X2 ; therefore doesn’t block information
* C is serial connection and in X2 ; therefore does block information
* Therefore, A and D are separated by this path.

Consider this alternative path:

A E C G D

* E is diverging connection and it is not in X2 ; therefore doesn’t block information
* C is serial connection and in X2 ; therefore does block information
* Therefore, A and D are separated by this path.

Consider the following alternative path:

A B C G D

A E C F D

In all above paths,

* C is serial connection and in X2 ; therefore does block information
* Therefore, A and D are separated by this path.

Conclusion: Therefore, A and D are d-separated given {C,H}.

1. d-sep(A,B / {F,E})

X1 = A

X3 = B

X2 = {F,E}

A E G F B

* E is serial connection and it is in X2 ; therefore does block information
* Therefore, A and B are d-separated given {F,E}.

Consider this path:

A E H F B

* E is converging connection and it is in X2 ; therefore doesn’t block information.
* H is diverging connection and not in X2 ; therefore doesn’t block information.
* F is serial connection and not in X2 ; therefore doesn’t block information.
* Therefore, A and B are not d-separated.

Conclusion: Therefore, we found this one path which proves A and B are not d-separated given {F,E}.

1. d-sep(C,D / {B})

X1 = C

X3 = D

X2 = {B}

C E G F D

* E is diverging connection and it is in X2 ; therefore doesn’t block information.
* G is serial connection and not in X2 ; therefore doesn’t block information.
* F is converging connection and not in X2 ; therefore does block information.
* Therefore, C and D are d-separated given {B}.

Consider this path:

C E H F D

* E is diverging connection and it is in X2 ; therefore doesn’t block information.
* H is serial connection and not in X2 ; therefore doesn’t block information.
* F is converging connection and not in X2 ; therefore does block information.
* Therefore, C and D are d-separated given {B}.

Conclusion: C and D are d-separated given {B}.

# Q2

1. **Compute P(E)**

P(E) = P(E | B) \* P(B) + P(E |~ B) \* P(~B)

P(B) = P(B | A) \* P(A) + P(B | ~A) \* P(~A)

P(E) = P(E | B) \* P(B | A) \* P(A) +

P(E | B) \* P(B | ~A) \* P(~A) +

P(E |~ B) \* P(~B | A) \* P(A) +

P(E |~ B) \* P(~B | ~A) \* P(~A)

= 0.6 \* 0.2 \* 0.75 +

0.6 \* 0.5 \* 0.25 +

0.3 \* 0.8 \* 0.75 +

0.3 \* 0.5 \* 0.25

= 0.09 + 0.075 + 0.18 + 0.0375

= 0.3825

1. **Compute P(~B,C,D,E)**

P(~B,C,D,E) = P(D|~B,C) \* P(C) \* P(E | ~B) \* P(~B)

= P(D|~B,C) \* P(C | A) \* P(E | ~B) \* P(~B | A) \* P(A)

+ P(D|~B,C) \* P(C | ~A) \* P(E | ~B) \* P(~B | ~A) \* P(~A)

= 0.1 \* 0.7 \* 0.3 \* 0.8 \* 0.75 + ( 0.1 \* 0.25 \* 0.3 \* 0.5 \* 0.25)

= 0.0126 + 0.0009375

= 0.0135375

1. **Compute P(D | A)**

P(A,B,C,D) = P(D | B,C) \* P(B|A) \* P(C|A) \* P(A)

= 0.3 \* 0.2 \* 0.7 \* 0.75

= 0.0315

P(A,B,~C,D) = P(D | B,~C) \* P(B|A) \* P(~C|A) \* P(A)

= 0.25 \* 0.2 \* 0.3 \* 0.75

= 0.01125

P(A,~B,C,D) = P(D | ~B,C) \* P(~B|A) \* P(C|A) \* P(A)

= 0.1 \* 0.8 \* 0.7 \* 0.75

= 0.042

P(A,~B,~C,D) = P(D | ~B,~C) \* P(~B|A) \* P(~C|A) \* P(A)

= 0.35 \* 0.8 \* 0.3 \* 0.75

= 0.063

P(D,A) = P(A,B,C,D) + P(A,B,~C,D) + P(A,~B,C,D) + P(A,~B,~C,D)

= 0.0315 + 0.01125 + 0.042 + 0.063

= 0.14775

P(D | A) = P(D,A) / P(A)

= 0.14775/ 0.75

= 0.197

# 

# Q5 SVM Theory

Weight Vector

Given Datapoints:

|  |  |  |
| --- | --- | --- |
| X1 | X2 | Y (Class Label) |
| 1 | 4 | 1 |
| 3 | 2 | 1 |
| 5 | 4 | 2 |
| 5 | 6 | 2 |

( I )

Class 1 (label 1)

Positive Hyperplane : WX1 + W0 = 1

Class 2 (label -1)

Negative Hyperplane : WX1 + W0 = -1

Let’s say Weight vector w = [w1 w2]

As per given hint that, w1 = w2

Considering support vectors to be (3,2), (1,4) and (5,4)

For support vector (3,2) -> Class 1 (label 1),

+ W0 = 1 -> 3 w1 + 2 w2 + W0 = 1 ……….. (i)

For support vector (3,2) -> Class 1 (label 1),

+ W0 = 1 -> w1 + 4 w2 + W0 = 1 ……….. (ii)

For support vector (5,4) -> Class 2 (label -1),

+ W0 = - 1 -> 5w1 + 4 w2 + W0 = -1 ……….. (iii)

(iii) - (ii)

4 w1 = -2

**w1 = - 0.5 ……….. (iv)**

Substituting value of w1 into (i) and (ii)

- 3.5 + 2 w2 + W0 = 1 ……….. (v)

- 0.5 + 4 w2 + W0 = 1 ……….. (vi)

(vi) - (v)

1 + 2w2 = 0

**w2 = - 0.5 ……….. (vii)**

substituting values of w1 and w2 into (i)

3 (-0.5) + 2 (-0.5) + w0  = 1

w0  = 1 + 1.5 + 1

w0  = 3.5

Therefore, weighted vector, W = [-0.5 -0.5]

Bias W0 = 3.5

( ii ) Support Vectors and Decision Boundary

Decision Boundary : WX1 + W0 = 0

+ W0 = 0

- 0.5X1 - 0.5X2  + 3.5 = 0

X2  = -X1 + 7

