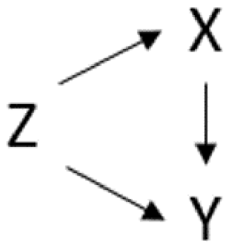
Advanced Artificial Intelligence - 2122 CMP9132M-2122

Advanced Artificial Intelligence Assignment Report

The solution to a) was derived from the Artificial Neural Networks, workshop 2's example of collecting probabilities from data.



X=0	Z=1	$P(Y \mid X,Z)$	$P(Y \mid X,\neg Z)$
T	T	0.81	0.19
T	F	0.48	0.52
F	T	0.83	0.17
F	F	0.55	0.45
P(X=1)	P(Z=1)	$P(Y \mid X,Z)$	$P(Y \mid X,\neg Z)$
T	T	0.76	0.24
T	F	0.55	0.45
F	T	0.87	0.13
F	F	0.54	0.46
P(X=2)	P(Z=1)	$P(Y \mid X,Z)$	$P(Y \mid X,\neg Z)$
T	T	0.91	0.09
T	F	0.55	0.45
F	T	0.77	0.23
F	F	0.54	0.46
Z	0.728	0.272	

No treatment		
Z	$P(x0 \mid Z)$	
TRUE	0.61	0.39
FALSE	0.04	0.96
Placebo		
Z	$P(x1 \mid Z)$	
TRUE	0.49	0.51
FALSE	0.08	0.92
Medicine		
Z	$P(x2 \mid Z)$	$P(x2/X \mid \neg Z)$
TRUE	0.09	0.91
FALSE	0.902	0.098
Y	0.746	0.254

This is possible for the values of X as well which give us a table of 12 elements.

For a given probability P(y,x,z), the expansion of this gives us the following:

$P(Y|X,Z)$, $P(X,Z)$, $P(Z)$

To compute the intervention's probability for part b, I wrote a function that takes in the values of x,y and z and then computes the intervention for all given values of X=0,1,2 and Z = 1,0. This returned the probability of Y being true and not being true for the cases

```
def y_do_x(y_x_z, y_x_not_z, y_not_x_z,y_not_x_not_z,z):
    y1_x1 = (y_x_z * z[t]) + (y_x_not_z * z[f])

    y1_x0 = (y_not_x_z * z[t]) + (y_not_x_not_z * z[f])

    return y1_x1, y1_x0
    #Computes Y TRUE/FALSE given Z is TRUE
    #AND Y TRUE/FALSE Given Z is false
```

```
y_do_x(p_y_x0_z1,p_y_x0_z0,p_y_x1_z1,p_y_x1_z0,Z)
```

```
(array([0.28259259, 0.71740741]), array([0.2998885, 0.7001115]))
```

```
y_do_x(p_y_x1_z1,p_y_x1_z0,p_y_x0_z1,p_y_x0_z0,Z)
```

```
(array([0.2998885, 0.7001115]), array([0.28259259, 0.71740741]))
```

```
y_do_x(p_y_x2_z1,p_y_x2_z0,p_y_x2_z1,p_y_x2_z0,Z)
```

```
(array([0.18778731, 0.81221269]), array([0.18778731, 0.81221269]))
```

For part C I based my solution on the workshop 3 example based on the condition that:

W in the full probability has no Parents and therefore the pre- and post-intervention are the same:
P(y|do(w)) = P(y|w)

P(Y|w)=αP(Y,w)

=α ∑z,x P(Y,x,w,z)

=α ∑z∑xP(Y|x,z) * P(x|z) * P(z|w) * P(w)

=α P(x|z) * ∑zP(z|w) * ∑xP(Y|x,z) * P(w)

P(Y|W)=⟨--(*P*(y|w),*P*(¬y|w)--) + (--*P*(y|¬w),*P*(¬y|¬w)--)⟩:

```
#Y|do(x),W
def Y_W(y_x_z, y_not_x_z, y_not_x_not_z, y_x_not_z, x_z,x_not_z,z_w,w):
    y1_w1 = w[t]*(z_w[t,t]*(y_x_z[t] *x_z[t] + y_not_x_z*x_z[f])
                + z_w[f,t]*(y_x_not_z[t] *x_not_z[t] + y_not_x_not_z[t] *x_not_z[f]))

    y1_w0 = w[f]*(z_w[t,f]*(y_x_z[t] *x_z[t] + y_not_x_z*x_z[f])
                + z_w[f,f]*((y_x_not_z[t] *x_not_z[t] + y_not_x_not_z[t] *x_not_z[f])))

    return y1_w1 - y1_w0
```

```
sum1 = Y_W(p_y_x1_z1,P_of_not_x1_given_z1,p_y_not_x1_z0,p_y_x1_z0,p_x1_z1,p_x1_z0,P_Z_W,P_W)#y/x1
sum0 = Y_W(p_y_x0_z1,P_of_not_x0_given_z1,p_y_not_x0_z0,p_y_x0_z0,p_x0_z1,P_x0_z0,P_Z_W,P_W)#y/x0
sum2 = Y_W(p_y_x2_z1,P_of_not_x2_given_z1,p_y_not_x2_z0,p_y_x2_z0,p_x2_z1,p_x2_z0,P_Z_W,P_W)#y/x2

Output = sum0+sum1+sum2
Output
```

```
0.7082547442053746
```

References

Nicola, B. (2021) Lecture 3 – Bayesian Networks, University of Lincoln,25th October. Available from: https://blackboard.lincoln.ac.uk/webapps/blackboard/content/listContent.jsp?course_id=_166752_1&content_id=_5852525_1 [Accessed: 02/12/21]

Nicola, B. (2021) Lecture 6 – Casual Inference I, University of Lincoln, 15th November. Available from: https://blackboard.lincoln.ac.uk/ultra/courses/_166752_1/cl/outline [Accessed: 02/12/21]