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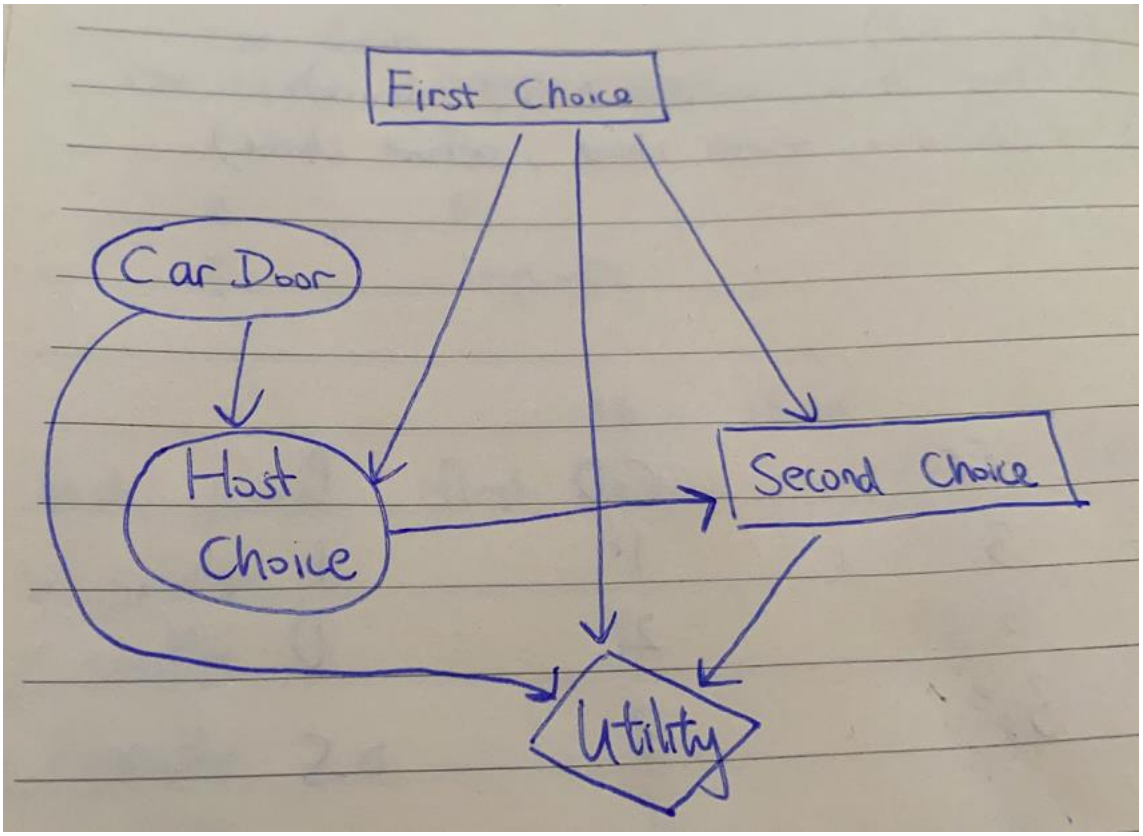
1 Decision Network for \Monty Hall" (28 marks)



Car Door	
Car Door	**Prob(Car Door)**
1	**p1**
2	**p2**
3	**1-p1-p2**

Host Choice			
Host Choice	**First Choice**	**Car Door**	**Prob(Host Choice| Car Door and First Choice)**
Smaller	**1**	**1**	**0.5**
Bigger	**1**	**1**	**0.5**
Smaller	**1**	**2**	**0**
Bigger	**1**	**2**	**1**
Smaller	**1**	**3**	**1**
Bigger	**1**	**3**	**0**

Smaller	**2**	**1**	**0**
bigger	**2**	**1**	**1**
Smaller	**2**	**2**	**0.5**
Bigger	**2**	**2**	**0.5**
Smaller	**2**	**3**	**1**
Bigger	**2**	**3**	**0**
Smaller	**3**	**1**	**0**
Bigger	**3**	**1**	**1**
Smaller	**3**	**2**	**1**
bigger	**3**	**2**	**0**
Smaller	**3**	**3**	**0.5**
bigger	**3**	**3**	**0.5**

The utility function			
Car door	**First choice**	**Second choice**	**U(car door, first choice, second choice)**
1	**1**	**stay**	**1**
1	**1**	**switch**	**0**
1	**2**	**stay**	**0**
1	**2**	**switch**	**1**
1	**3**	**stay**	**0**
1	**3**	**switch**	**1**
2	**1**	**stay**	**0**
2	**1**	**switch**	**1**
2	**2**	**stay**	**1**
2	**2**	**switch**	**0**
2	**3**	**stay**	**0**
2	**3**	**switch**	**1**
3	**1**	**stay**	**0**
3	**1**	**switch**	**1**
3	**2**	**stay**	**0**
3	**2**	**switch**	**1**
3	**3**	**stay**	**1**
3	**3**	**switch**	**0**

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2. p1 = 1/3, p2=1/3, p3=1/3

f1(Car Door)	
Car Door	**Val**
1	**1/3**
2	**1/3**
3	**1/3**

f2(Host Choice, Car Door, First Choice)			
Host Choice	**First Choice**	**Car Door**	**Val**
Smaller	**1**	**1**	**0.5**
Bigger	**1**	**1**	**0.5**
Smaller	**1**	**2**	**0**
Bigger	**1**	**2**	**1**
Smaller	**1**	**3**	**1**
Bigger	**1**	**3**	**0**
Smaller	**2**	**1**	**0**
bigger	**2**	**1**	**1**
Smaller	**2**	**2**	**0.5**
Bigger	**2**	**2**	**0.5**
Smaller	**2**	**3**	**1**
Bigger	**2**	**3**	**0**
Smaller	**3**	**1**	**0**
Bigger	**3**	**1**	**1**
Smaller	**3**	**2**	**1**
bigger	**3**	**2**	**0**
Smaller	**3**	**3**	**0.5**
bigger	**3**	**3**	**0.5**

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f3(Car Door, First Choice, Second Choice)			
Car door	**First choice**	**Second choice**	**Val**
1	1	stay	1
1	1	switch	0
1	2	stay	0
1	2	switch	1
1	3	stay	0
1	3	switch	1
2	1	stay	0
2	1	switch	1
2	2	stay	1
2	2	switch	0
2	3	stay	0
2	3	switch	1
3	1	stay	0
3	1	switch	1
3	2	stay	0
3	2	switch	1
3	3	stay	1
3	3	switch	0

Factor list: f1,f2,f3

Multiply f1 by f2 to get f4 (host choice, car door, first choice)

Factor list: f3,f4

F4(host choice,car door, first choice)			
Host Choice	**Car Door**	**First Choice**	**Val**
Smaller	1	1	1/6
Bigger	1	1	1/6
Smaller	2	1	0
Bigger	2	1	1/3
Smaller	3	1	1/3
Bigger	3	1	0
Smaller	1	2	0
bigger	1	2	1/3
Smaller	2	2	1/6
Bigger	2	2	1/6
Smaller	3	2	1/3
Bigger	3	2	0
Smaller	1	3	0
Bigger	1	3	1/3
Smaller	2	3	1/3
bigger	2	3	0
Smaller	3	3	1/6
bigger	3	3	1/6

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Multiply f4 by f3 to get f5(host choice, car door, first choice, second choice)

Factor list: f5

	F5(host choice, First Choice, Car Door, Second Choice)			
Host choice	**First Choice**	**Car Door**	**Second choice**	**Val**
Smaller	**1**	**1**	**stay**	**1/6**
Bigger	**1**	**1**	**stay**	**1/6**
Smaller	**1**	**1**	**switch**	**0**
Bigger	**1**	**1**	**switch**	**0**
Smaller	**1**	**2**	**stay**	**0**
Bigger	**1**	**2**	**stay**	**0**
Smaller	**1**	**2**	**switch**	**0**
Bigger	**1**	**2**	**switch**	**1/3**
Smaller	**1**	**3**	**stay**	**0**
Bigger	**1**	**3**	**stay**	**0**
Smaller	**1**	**3**	**switch**	**1/3**
Bigger	**1**	**3**	**switch**	**0**
Smaller	**2**	**1**	**stay**	**0**
Bigger	**2**	**1**	**stay**	**0**
Smaller	**2**	**1**	**switch**	**0**
bigger	**2**	**1**	**switch**	**1/3**
smaller	**2**	**2**	**stay**	**1/6**
bigger	**2**	**2**	**stay**	**1/6**
smaller	**2**	**2**	**switch**	**0**
Bigger	**2**	**2**	**switch**	**0**
Smaller	**2**	**3**	**stay**	**0**
Bigger	**2**	**3**	**stay**	**0**
Smaller	**2**	**3**	**switch**	**1/3**
Bigger	**2**	**3**	**switch**	**0**
Smaller	**3**	**1**	**stay**	**0**
Bigger	**3**	**1**	**stay**	**0**
Smaller	**3**	**1**	**switch**	**0**
Bigger	**3**	**1**	**switch**	**1/3**
Smaller	**3**	**2**	**stay**	**0**
Bigger	**3**	**2**	**stay**	**0**
Smaller	**3**	**2**	**switch**	**1/3**
Bigger	**3**	**2**	**switch**	**0**
Smaller	**3**	**3**	**stay**	**1/6**
Bigger	**3**	**3**	**stay**	**1/6**
Smaller	**3**	**3**	**switch**	**0**
bigger	**3**	**3**	**switch**	**0**

Sum out Car door from f5 to get f6(host choice, first choice, second choice)

Factor list: f6

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F6(host choice, first choice, second choice)			
Host choice	**first choice**	**Second choice**	**val**
Smaller	**1**	**Stay**	**1/6**
Bigger	**1**	**Stay**	**1/6**
Smaller	**1**	**Switch**	**1/3**
Bigger	**1**	**Switch**	**1/3**
Smaller	**2**	**Stay**	**1/6**
Bigger	**2**	**Stay**	**1/6**
Smaller	**2**	**Switch**	**1/3**
Bigger	**2**	**Switch**	**1/3**
Smaller	**3**	**Stay**	**1/6**
Bigger	**3**	**Stay**	**1/6**
Smaller	**3**	**Switch**	**1/3**
Bigger	**3**	**Switch**	**1/3**

From f6, determine the optimal policy for second choice

Optimal policy for second choice		
Host choice	**first choice**	**Second choice**
Smaller	**1**	**Switch**
Bigger	**1**	**Switch**
Smaller	**2**	**Switch**
Bigger	**2**	**Switch**
Smaller	**3**	**Switch**
Bigger	**3**	**Switch**

F7 is being created after determining the optimal policy:

F7(host choice, first choice)		
Host choice	**first choice**	**val**
Smaller	**1**	**1/3**
Bigger	**1**	**1/3**
Smaller	**2**	**1/3**
Bigger	**2**	**1/3**
Smaller	**3**	**1/3**
Bigger	**3**	**1/3**

Factor list: f8

F8(first choice)	
first choice	**val**
1	**2/3**
2	**2/3**
3	**2/3**

Optimal policy for the first choice: choose anything

Expected Utility of the optimal choice = 2/3

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3. p1 = 0.8, p2=0.1, p3=0.1

f1(Car Door)	
Car Door	**Val**
1	**0.8**
2	**0.1**
3	**0.1**

f2(Host Choice, Car Door, First Choice)			
Host Choice	**First Choice**	**Car Door**	**Val**
Smaller	**1**	**1**	**0.5**
Bigger	**1**	**1**	**0.5**
Smaller	**1**	**2**	**0**
Bigger	**1**	**2**	**1**
Smaller	**1**	**3**	**1**
Bigger	**1**	**3**	**0**
Smaller	**2**	**1**	**0**
bigger	**2**	**1**	**1**
Smaller	**2**	**2**	**0.5**
Bigger	**2**	**2**	**0.5**
Smaller	**2**	**3**	**1**
Bigger	**2**	**3**	**0**
Smaller	**3**	**1**	**0**
Bigger	**3**	**1**	**1**
Smaller	**3**	**2**	**1**
bigger	**3**	**2**	**0**
Smaller	**3**	**3**	**0.5**
bigger	**3**	**3**	**0.5**

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f3(Car Door, First Choice, Second Choice)			
Car door	**First choice**	**Second choice**	**Val**
1	1	stay	1
1	1	switch	0
1	2	stay	0
1	2	switch	1
1	3	stay	0
1	3	switch	1
2	1	stay	0
2	1	switch	1
2	2	stay	1
2	2	switch	0
2	3	stay	0
2	3	switch	1
3	1	stay	0
3	1	switch	1
3	2	stay	0
3	2	switch	1
3	3	stay	1
3	3	switch	0

Factor list: f1,f2,f3

Multiply f1 by f2 to get f4 (host choice, car door, first choice)

Factor list: f3,f4

F4(host choice,car door, first choice)			
Host Choice	**Car Door**	**First Choice**	**Val**
Smaller	1	1	0.4
Bigger	1	1	0.4
Smaller	2	1	0
Bigger	2	1	0.1
Smaller	3	1	0.1
Bigger	3	1	0
Smaller	1	2	0
bigger	1	2	0.8
Smaller	2	2	0.05
Bigger	2	2	0.05
Smaller	3	2	0.1
Bigger	3	2	0
Smaller	1	3	0
Bigger	1	3	0.8
Smaller	2	3	0.1
bigger	2	3	0
Smaller	3	3	0.05
bigger	3	3	0.05

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Multiply f4 by f3 to get f5(host choice, car door, first choice, second choice)

Factor list: f5

	F5(host choice, First Choice, Car Door, Second Choice)			
Host choice	**First Choice**	**Car Door**	**Second choice**	**Val**
Smaller	**1**	**1**	**stay**	**0.4**
Bigger	**1**	**1**	**stay**	**0.4**
Smaller	**1**	**1**	**switch**	**0**
Bigger	**1**	**1**	**switch**	**0**
Smaller	**1**	**2**	**stay**	**0**
Bigger	**1**	**2**	**stay**	**0**
Smaller	**1**	**2**	**switch**	**0**
Bigger	**1**	**2**	**switch**	**0.1**
Smaller	**1**	**3**	**stay**	**0**
Bigger	**1**	**3**	**stay**	**0**
Smaller	**1**	**3**	**switch**	**0.1**
Bigger	**1**	**3**	**switch**	**0**
Smaller	**2**	**1**	**stay**	**0**
Bigger	**2**	**1**	**stay**	**0**
Smaller	**2**	**1**	**switch**	**0**
bigger	**2**	**1**	**switch**	**0.8**
smaller	**2**	**2**	**stay**	**0.05**
bigger	**2**	**2**	**stay**	**0.05**
smaller	**2**	**2**	**switch**	**0**
Bigger	**2**	**2**	**switch**	**0**
Smaller	**2**	**3**	**stay**	**0**
Bigger	**2**	**3**	**stay**	**0**
Smaller	**2**	**3**	**switch**	**0.1**
Bigger	**2**	**3**	**switch**	**0**
Smaller	**3**	**1**	**stay**	**0**
Bigger	**3**	**1**	**stay**	**0**
Smaller	**3**	**1**	**switch**	**0**
Bigger	**3**	**1**	**switch**	**0.8**
Smaller	**3**	**2**	**stay**	**0**
Bigger	**3**	**2**	**stay**	**0**
Smaller	**3**	**2**	**switch**	**0.1**
Bigger	**3**	**2**	**switch**	**0**
Smaller	**3**	**3**	**stay**	**0.05**
Bigger	**3**	**3**	**stay**	**0.05**
Smaller	**3**	**3**	**switch**	**0**
bigger	**3**	**3**	**switch**	**0**

Sum out Car door from f5 to get f6(host choice, first choice, second choice)

Factor list: f6

F6(host choice, first choice, second choice)			
Host choice	**first choice**	**Second choice**	**val**

Smaller	**1**	**Stay**	**0.4**
Bigger	**1**	**Stay**	**0.4**
Smaller	**1**	**Switch**	**0.1**
Bigger	**1**	**Switch**	**0.1**
Smaller	**2**	**Stay**	**0.05**
Bigger	**2**	**Stay**	**0.05**
Smaller	**2**	**Switch**	**0.1**
Bigger	**2**	**Switch**	**0.8**
Smaller	**3**	**Stay**	**0.05**
Bigger	**3**	**Stay**	**0.05**
Smaller	**3**	**Switch**	**0.1**
Bigger	**3**	**Switch**	**0.8**

From f6, determine the optimal policy for second choice

Optimal policy for second choice		
Host choice	**first choice**	**Second choice**
Smaller	**1**	**Stay**
Bigger	**1**	**Stay**
Smaller	**2**	**Switch**
Bigger	**2**	**Switch**
Smaller	**3**	**Switch**
Bigger	**3**	**Switch**

F7 is being created after determining the optimal policy:

F7(host choice, first choice)		
Host choice	**first choice**	**val**
Smaller	**1**	**0.4**
Bigger	**1**	**0.4**
Smaller	**2**	**0.1**
Bigger	**2**	**0.8**
Smaller	**3**	**0.1**
Bigger	**3**	**0.8**

Factor list: f8

F8(first choice)	
first choice	**val**
1	**0.9**
2	**0.9**
3	**0.9**

Optimal policy for the first choice: choose 2 or 3

Expected Utility of the optimal choice = 0.9

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2 Reinforcement Learning (36 marks)

1.
```
The long term utility values for grid lecture:
[[ 0.705548  0.654131  0.6098    0.469813]
 [ 0.760959  0.        0.66902  -1.      ]
 [ 0.811043  0.867702  0.917319  1.      ]]
```

2.
```
The optimal policy for grid lecture:
[['down ' 'left ' 'left ' 'left ']
 ['down ' 'X    ' 'down ' '-1   ']
 ['right' 'right' 'right' '1    ']]
```

3.
```
The long term utility values for grid a4:
[[-0.133841  0.010468  0.200468  0.383342]
 [-0.267863 -0.22003   0.        0.571973]
 [-0.435932 -1.        1.        0.780025]]
```

4.
```
The optimal policy for grid a4:
[['right' 'right' 'right' 'down ']
 ['up   ' 'up   ' 'X    ' 'down ']
 ['up   ' '-1   ' '1    ' 'left ']]
```