Data Analysis

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Question (a) - How many different models are there for this data?

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possible edges:   n*(n-1)/2 = 10*(10-1)/2 = 45
possible models:  2^45 = 35184372088832
```

Question (b) - How many cells does the table of counts for this data set have? How many parameters does the saturated model have?

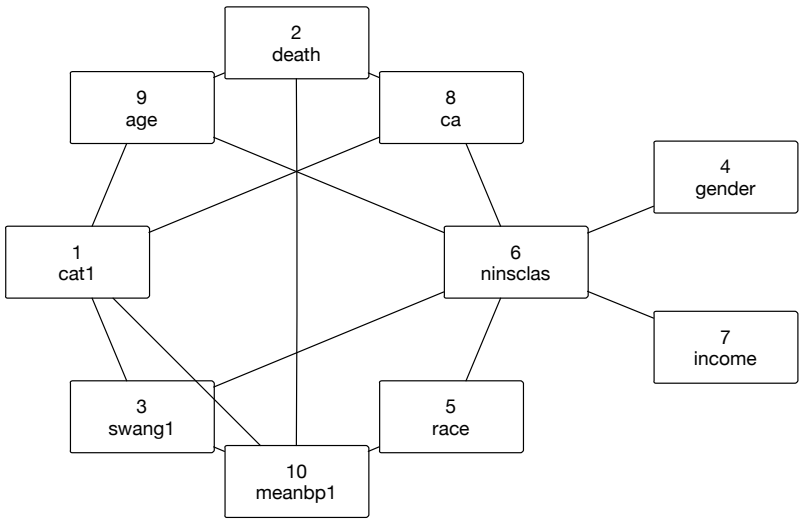
	cat1	death	swang1	gender	race	ninsclas	income	ca	age	meanbp1
values	9	2	2	2	3	6	4	3	5	2

```
9*2*2*2*3*6*4*3*5*2 = 155520 number of cells
8*1*1*1*2*5*3*2*4*1 = 1920 number of parameters
```

Question (c) - Independence model using BIC score

13 cliques, BIC score 15841.66 *(independence model)*												
1 8	**1** **9**	1 3 10	2 8	2 9	2 10	**3** **6**	4 6	**5** **6**	6 7	6 8	6 9	5 10

TRACE
1. Add: 9 − 6 (score= 20139.73)
2. Add: 8 − 1 (score= 18561.18)
3. Add: 7 − 6 (score= 17313.90)
4. Add: 3 − 1 (score= 16947.05)
5. Add: 8 − 2 (score= 16706.60)
6. Add: 6 − 5 (score= 16466.82)
7. Add: 10 − 3 (score= 16227.81)
8. Add: 9 − 2 (score= 16024.58)
9. Add: 9 − 1 (score= 15936.67)
10. Add: 10 − 2 (score= 15899.67)
11. Add: 10 − 1 (score= 15878.31)
12. Add: 10 − 5 (score= 15857.81)
13. Add: 6 − 4 (score= 15847.04)
14. Add: 6 − 3 (score= 15843.36)
15. Add: 8 − 6 (score= 15841.66)



Question (d) - Independencies

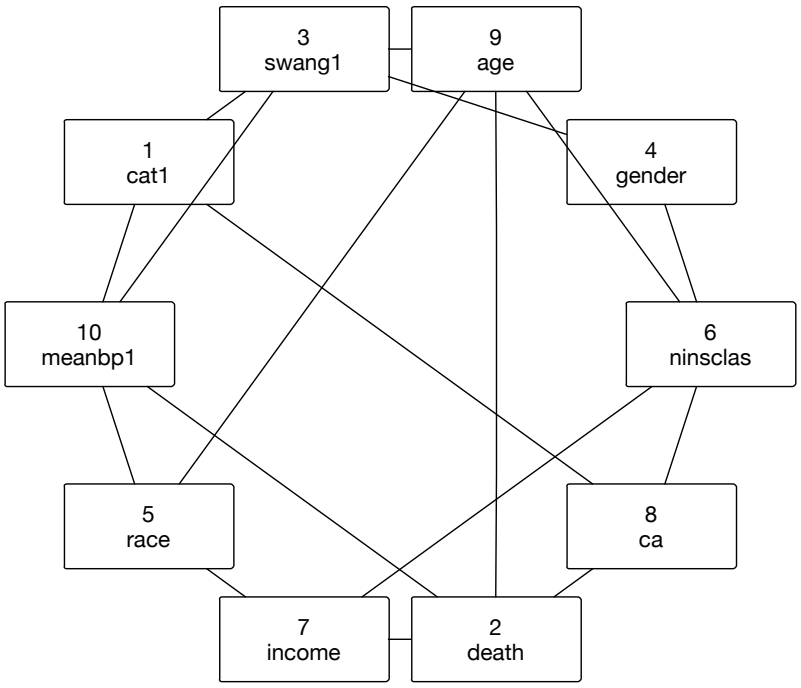
Gender and income are independent given ninsclas (**gender ⊥ income | ninsclas**). Which means that when you pick some value for ninsclas then gender and income are independent. Some other formulation is that gender and income looks related but that have only to do with the fact that both relates to ninclas.

If you are interested in predicting whether or not someone survives, you must look at the direct dependencies of the variable 'death', which means that it depends on cancer status (ca), age and blood pressure (meanbp1).

Question (e) - Saturated model using BIC score

15 cliques, BIC score 15850.53 *(saturated model)*														
1 3 10	1 8	**2** **7**	2 8	2 9	2 10	**3** **4**	4 6	**5** **7**	**5** **9**	5 10	6 7	6 8	**3** **9**	6 9

TRACE
1. Remove: 6 – 1 (score= 352418.67)
2. Remove: 9 – 7 (score= 145996.05)
3. Remove: 8 – 5 (score= 85022.56)
4. Remove: 2 – 1 (score= 64150.58)
5. Remove: 4 – 3 (score= 51172.69)
6. Remove: 6 – 2 (score= 41682.01)
7. Remove: 10 – 1 (score= 34213.22)
8. Remove: 10 – 6 (score= 29598.23)
9. Remove: 9 – 1 (score= 26137.86)
10. Remove: 7 – 1 (score= 23410.33)
11. Remove: 8 – 6 (score= 21604.37)
12. Remove: 6 – 5 (score= 19937.64)
13. Remove: 10 – 9 (score= 19036.88)
14. Remove: 10 – 7 (score= 18358.74)
15. Remove: 5 – 2 (score= 17953.09)
16. Remove: 8 – 3 (score= 17582.91)
17. Remove: 8 – 4 (score= 17231.89)
18. Remove: 5 – 1 (score= 16916.77)
19. Remove: 6 – 3 (score= 16633.86)
20. Remove: 6 – 4 (score= 16404.68)
21. Remove: 5 – 3 (score= 16269.59)
22. Remove: 5 – 4 (score= 16145.29)
23. Remove: 7 – 2 (score= 16062.76)
24. Remove: 9 – 8 (score= 16011.30)
25. Remove: 4 – 2 (score= 15969.11)
26. Remove: 3 – 2 (score= 15935.30)
27. Remove: 8 – 7 (score= 15913.10)
28. Remove: 4 – 1 (score= 15903.07)
29. Remove: 7 – 3 (score= 15897.47)
30. Remove: 7 – 4 (score= 15892.60)
31. Add: 8 – 6 (score= 15889.27)
32. Remove: 9 – 4 (score= 15886.83)
33. Add: 6 – 4 (score= 15876.29)
34. Remove: 10 – 8 (score= 15873.92)
35. Add: 10 – 1 (score= 15856.19)
36. Remove: 10 – 4 (score= 15854.62)
37. Add: 4 – 3 (score= 15851.79)
38. Add: 7 – 2 (score= 15850.53)



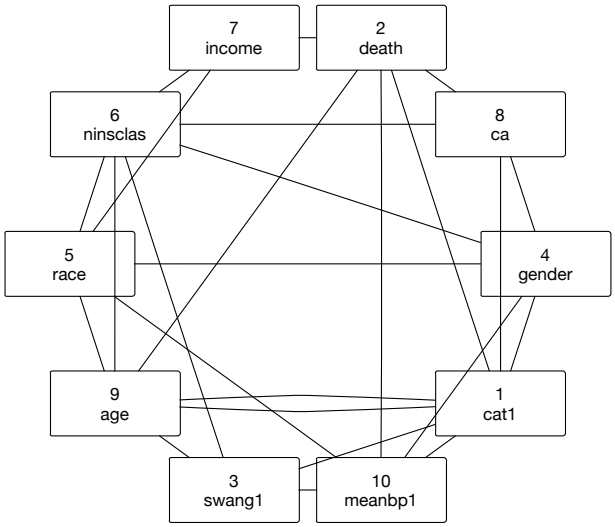
The difference between this saturated model and the model we found in (c) is that this model contains more relations and is therefore less independent. There are some new relations such as income-death, swang1-gender, race-income, race-age and swang1-age, while other relations are omitted such as cat1-age, swang1-ninsclas and race-ninsclas.
So ninsclas is less dependent in the saturated model, while death, age, income and gender have now more dependencies. The saturated model have a slightly lower BIC score.

Question (f) - Independence and saturated model using AIC score

The models are the same.

14 cliques, AIC score 14278.21 *(independence model)*													
1 2 8	1 2 9	1 2 10	1 3 9	1 3 10	1 4 8	1 4 10	4 5 6	4 5 10	5 6 7	5 6 9	3 6 9	4 6 8	2 7

14 cliques, AIC score 14278.21 *(saturated model)*													
1 2 8	1 2 9	1 2 10	1 3 9	1 3 10	1 4 8	1 4 10	4 5 6	4 5 10	5 6 7	5 6 9	3 6 9	4 6 8	2 7



Question (g) - Difference between AIC and BIC

There are more relations in AIC than BIC. All relations will be found by AIC, because it have the same results for the saturated as independence model.
Maybe AIC will find too many relations to say something useful, because of overfitting, while BIC will stop earlier.

Question (h) - Random restarts

We use the following configuration:

	score type	prob	nstart	result score
A-0.25 (1)	AIC	0.25	1	14278.21
A-0.25 (3)	AIC	0.25	3	14278.21
A-0.25 (9)	AIC	0.25	9	14263.97
A-0.5 (1)	AIC	0.5	1	14341.65
A-0.5 (3)	AIC	0.5	3	14341.65

	score type	prob	nstart	result score
A-0.5 (9)	AIC	0.5	9	14263.97
A-0.75 (1)	AIC	0.75	1	14344.02
A-0.75 (3)	AIC	0.75	3	14344.02
A-0.75 (9)	AIC	0.75	9	14263.97
B-0.25 (1)	BIC	0.25	1	15783.74
B-0.25 (3)	BIC	0.25	3	15783.74
B-0.25 (9)	BIC	0.25	9	15783.74
B-0.5 (1)	BIC	0.5	1	16020.66
B-0.5 (3)	BIC	0.5	3	15783.74
B-0.5 (9)	BIC	0.5	9	15783.74
B-0.75 (1)	BIC	0.75	1	15905.88
B-0.75 (3)	BIC	0.75	3	15850.53
B-0.75 (9)	BIC	0.75	9	15783.74

For both AIC and BIC we found the best results if we do many restarts.

Furthermore we see that a probability of 0.25 will give this same best result for all runs of BIC and almost the best result for AIC. So 0.25 is likely a preferable probability.

We also conclude that BIC will easier converge, because we found the same result several times, while in the AIC case we have slightly different values for most runs.