1. Total Number 2201

1st: 325

2nd: 285

3rd: 706

crew: 885
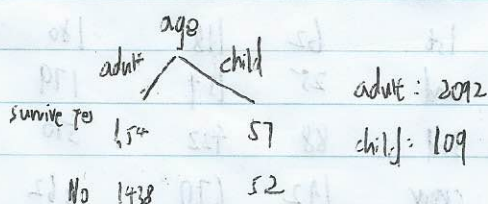
P. class.

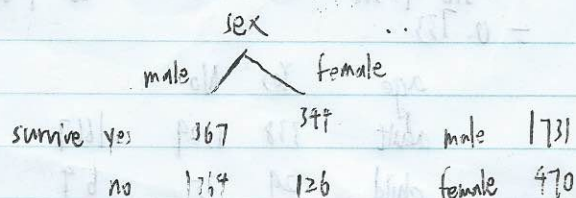|	1	2	3	Crew
survive Yes	203	118	178	212
No	122	167	528	673

$$\text{Entropy} = \text{entropy}\left(\frac{203}{325}, \frac{122}{325}\right)\frac{325}{2201} + \text{entropy}\left(\frac{118}{285}, \frac{167}{285}\right)\frac{285}{2201}$$
$$+ \text{entropy}\left(\frac{178}{706}, \frac{528}{706}\right)\frac{706}{2201} + \text{entropy}\left(\frac{212}{885}, \frac{673}{885}\right)\frac{885}{2201}$$
$$= \left(-\frac{203}{325}\log_2\frac{203}{325} - \frac{122}{325}\log_2\frac{122}{325}\right)\frac{325}{2201} + \left(-\frac{118}{285}\log_2\frac{118}{285} - \frac{167}{285}\log_2\frac{167}{285}\right)\frac{285}{2201}$$
$$+ \left(-\frac{178}{706}\log_2\frac{178}{706} - \frac{528}{706}\log_2\frac{528}{706}\right)\frac{706}{2201} + \left(-\frac{212}{885}\log_2\frac{212}{885} - \frac{673}{885}\log_2\frac{673}{885}\right)\frac{885}{2201}$$
$$= 0.848$$

age

adult: 2092

child: 109

	adult	child
survive yes	654	57
No	1438	52

$$\text{Entropy} = \text{entropy}\left(\frac{654}{2092}, \frac{1438}{2092}\right)\frac{2092}{2201} + \text{entropy}\left(\frac{57}{109}, \frac{52}{109}\right)\frac{109}{2201}$$
$$= \left(-\frac{654}{2092}\log_2\frac{654}{2092} - \frac{1438}{2092}\log_2\frac{1438}{2092}\right)\frac{2092}{2201} + \left(-\frac{57}{109}\log_2\frac{57}{109} - \frac{52}{109}\log_2\frac{52}{109}\right)\frac{109}{2201}$$
$$= 0.901$$

sex

male 1731

female 470

	male	female
survive yes	367	344
no	1364	126

$$\text{Entropy} = \text{entropy}\left(\frac{367}{1731}, \frac{344}{1731}\right)\frac{1731}{2201} + \text{entropy}\left(\frac{344}{470}, \frac{126}{470}\right)\frac{470}{2201}$$
$$= \left(-\frac{367}{1731}\log_2\frac{367}{1731} - \frac{344}{1731}\log_2\frac{344}{1731}\right)\frac{1731}{2201} + \left(-\frac{344}{470}\log_2\frac{344}{470} - \frac{126}{470}\log_2\frac{126}{470}\right)\frac{470}{2201}$$
$$= 0.765$$

Sex will be the root

femail P class	Yes	No	
1st	141	4	145
2nd	93	13	106
3rd	90	106	196
Crew	20	3	23
			470

$$\text{entropy} = \left(-\frac{141}{145}\log_2\frac{141}{145} - \frac{4}{145}\log_2\frac{4}{145}\right)\frac{145}{470} + \left(-\frac{93}{106}\log_2\frac{93}{106} - \frac{16}{106}\log\frac{16}{106}\right)\frac{106}{470}$$
$$+ \left(-\frac{90}{196}\log_2\frac{90}{196} - \frac{106}{196}\log_2\frac{106}{196}\right)\frac{196}{470} + \left(-\frac{20}{23}\log_2\frac{20}{23} - \frac{3}{23}\log_2\frac{3}{23}\right)\frac{23}{470}$$
$$= 0.620$$

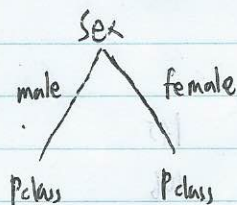| age	yes	no	
adult	316	109	425
child	28	17	45

$$\text{entropy} = \left(-\frac{316}{425}\log_2\frac{316}{425} - \frac{109}{425}\log_2\frac{109}{425}\right)\frac{425}{470} + \left(-\frac{28}{45}\log_2\frac{28}{45} - \frac{17}{45}\log_2\frac{17}{45}\right)\frac{45}{470}$$
$$= 0.834$$

male	P class	Yes	No	
	1st	62	118	180
	2nd	25	154	179
	3rd	88	422	510
	crew	192	670	862
				1731

$$\text{entropy} = \left(-\frac{62}{180}\log_2\frac{62}{180} - \frac{118}{180}\log_2\frac{118}{180}\right) + \left(-\frac{25}{179}\log_2\frac{25}{179} - \frac{154}{179}\log_2\frac{154}{179}\right)\frac{179}{173}$$
$$+ \left(\frac{88}{510}\log_2\frac{88}{510} - \frac{422}{510}\log_2\frac{422}{510}\right) + \left(-\frac{192}{862}\log_2\frac{192}{862} - \frac{670}{862}\log_2\frac{670}{862}\right)\frac{862}{173}$$
$$= 0.733$$

age	Yes	No	
adult	338	1329	1667
child	29	35	64
			1731

$$\text{entropy} = \left(-\frac{338}{1667}\log_2\frac{338}{1667} - \frac{1329}{1667}\log_2\frac{1329}{1667}\right)\frac{1667}{1751} + \left(-\frac{29}{64}\log_2\frac{29}{64} - \frac{35}{64}\log\frac{35}{64}\right)\frac{67}{1731}$$
$$= 0.737$$

Sex

male / \ female

Pclass   Pclass

2 outlook = sunny   2/5   2/5   2/2
   outlook = overcast   4/4
   outlook = rainy   3/5   3/5   2/3
   temperature = hot   2/4   0/2
   temperature = mild   4/6   3/5   2/2
   temperature = cold   3/4   2/3   2/3
   humidity = high   1/7   1/5
   humidity = normal   6/7   4/5
   windy = False   6/8   1/4   3/3
   windy = True   3/6   4/6   1/2

Thus if outlook = overcast, then play = yes
     if humidity = normal then play = yes
     if humidity = normal and windy = False, then play = yes

3 $P(survived = yes \mid E)$
   $= P(Pclass = 2nd \mid survived = yes)$
   $\times P(age = child \mid survived = yes)$
   $\times P(sex = male \mid survived = yes)$
   $\times P(survived = yes) / P(E)$
   $= \frac{118}{711} \times \frac{D}{711} \times \frac{167}{711} \times \frac{711}{2201} / P(E)$
   $= 0.0022 \, d$

   $P(survived = no \mid E)$
   $= P(Pclass = 2nd \mid survived = no)$
   $\times P(age = child \mid survived = no)$
   $\times P(sex = male \mid survived = no)$
   $\times P(survived = no) / P(E)$
   $= \frac{167}{1490} \times \frac{52}{1490} \times \frac{1364}{1490} \times \frac{1490}{2201} / P(E)$
   $= 0.0024 \, d$

   $d \cdot 0.0024 + d \cdot 0.0022 = 1$
   $d = 217.39$

P(survived = yes | E)

= 217.39 · 0.0022

≈ 47.8

P(survived = no | E)

= 52.2%

P(survived = yes | E)

= P(Pclass = 2nd | survived = yes)

× P(age =: adult | survived = yes)

× P(sex = female | survived = yes)

× P(survived = yes) / P(E)

= $\frac{118}{711} \times \frac{654}{711} \times \frac{344}{711} \times \frac{711}{2201}$ / P(E)

= 0.0219 d

P(survived = no | E)

= P(class = 2nd | survived = no)

× P(age = adult | survived = no)

× P(sex = female | survived = no)

× P(survived = yes) / P(E)

= $\frac{167}{1490} \times \frac{1418}{1490} \times \frac{126}{1490} \times \frac{1490}{2201}$ / P(E)

= 0.0062 d

0.0062 d + 0.0219 d = 1

d = 33.22

P(survived = yes | E)

= 0.0239 · 33.22

= 79.3

P(survived = no | E)

= 0.0062 × 33.22

= 20.7%