**Assignment 1: Advanced Business Decision Modelling**

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Assignment 1

**Problem 1:**

a)    Here are the list of combinations that contain a total sum of 7 or 11:

     (1,6) (2,5) (3,4) (4,3) (5,2) (6,1) (5,6) (6,5)

Regarding the list above, the number on the left represents the outcome of the first dice, while the number on the right represents the outcome of the second dice. There is a total of 36 outcomes since there are two dice with six possible combinations. (6^2 = 36)

Therefore,

P(E1+E2=7) = 8/36 = 2/9

b)    The condition for independence is as follows: P(A and B) = P(A)\*P(B). If this rule is violated, the events cannot be said to be independent.

P(E1) = 1/6

P(E2) = 3/36 = 1/12

P(E1 and E2) = 0

P(E1)\*P(E2) = 0.013889

     P(E1 and E2)≠P(E1)\*P(E2)

Therefore, they are NOT independent events.

c)   Event A = First die is equal to 3

Event B = sum of the two dice is equal to 7

P(A and B) = 1/6 \*1/6 = 1/36

P(A|B) = P(A and B) / P(B) = (1/36) / (1/6)

Therefore,

P(A|B) = 1/6

**Problem 2:**

a)       P(Engine Failure) = 0.001

         P(No Engine Failure) = 0.999

Therefore,

P(Crash) = (0.001)4 + 4\*(0.001)3\*(0.999) + 6\*(0.001)2\*(0.999)2

=5.992003 \* 10-6

b)     P(Engine Failure|Inspection is Good) =

P(Engine Failure & Inspection is Good) / P(Inspection is Good)

We can change this to:

= [P(Inspection is Good|Engine Failure)\*P(Engine Failure)] **/**

[P(Inspection is Good|Engine Failure)\*P(Engine Failure)+P(Inspection is Good|No Engine Failure)\*P(No Engine Failure)]

= (0.001\*0.001) / (0.001\*0.001 + 0.995\*0.999)

= 1.0060301446873 \* 10-6

c)       P(Engine Failure|Inspection is Good) = 1.0060301446873 \* 10-6

 P(No Engine Failure|Inspection is Good) = 0.999998994

Therefore,

P(Crash) = (1.0060301446873 \* 10-6)4 + 4\*(1.0060301446873 \* 10-6) 3 \* (0.999998994) + 6\*(1.0060301446873 \* 10-6) 2 \* (0.999998994) 2

=6.07257002 \* 10-12

d)       P(Engine Failure|Inspection is Bad) =

P(Engine Failure & Inspection is Bad) / P(Inspection is Bad)

We can change this to:

= [P(Inspection is Bad|Engine Failure)\*P(Engine Failure)] **/**

[P(Inspection is Bad|Engine Failure)\*P(Engine Failure)+P(Inspection is Bad|No Engine Failure)\*P(No Engine Failure)]

= (0.999\*0.001) / (0.999\*0.001+0.005\*0.999)

=0.16666666666667

Now we have the information to find the probability of a plane crash:

P(Crash) =

= [P(Engine Failure|Inspection is Good)] 3\*P(Engine Fail|Inspection is Bad) + 3\*P(No Engine Failure|Inspection is Good)\*[P(Engine Failure|Inspection is Good)]2\*P(Engine Failure|Inspection is Bad) +P[Engine Failure|Inspection is Good] 3\*P[No Engine Failure|Inspection is Bad] + 3\*[P(No Engine Failure|Inspection is Good)] 2\*P(Engine Failure|Inspection is Good)\*P(Engine Failure|Inspection is Bad) + 3\*P(No Engine Failure|Inspection is Good)\*[P(Engine Failure|Inspection is Good)] 2 \*P(No Engine Failure|Inspection is Bad)

=0.16667 \* 0.0000013 + 3 \* (0.16667 \* 0.0000012 \* (1 - 0.000001)) + (1 - 0.16667) \* 0.0000013 + 3 \* ((1 - 0.16667) \* 0.0000012 \* (1 - 0.000001)) + 3 \* (0.16667 \* 0.000001 \* (1 - 0.000001) 2)

The probability of a crash given the circumstances is:

= 5.00103 \* 10-7

**Problem 3:**

a) We have created our decision tree under two main assumptions. One related to the decision to wait 12 hours and the other related to the relative values of consequences under different decisions.

In our decision tree, we have a decision node separating the possible decisions of the doctor into two options: “Wait for 12 hours” and “Operate Now”. We have assumed that in the continuation of the “Wait for 12 hours” branch, we didn’t need any decision nodes of whether to operate or not. Since the decision tree is made following the decisions of the doctor, we assumed for the first branch that waiting 12 hours and knowing exactly the patient’s problem, the doctor will not operate under “NASP” and the doctor will operate under “normal appendicitis” and “perforated appendicitis”. Therefore, the decision of the doctor is clear after 12 hours since he does not want to take on the unnecessary risk of operating unless it is essential. Hence, we only have random outcomes of “Death” or “Live” at the end of the first branch.

We have identified 2 main consequences for the problem (“Death” or “Live”) and 2 sub-reasons for these consequences:

1. The Doctor Should Have Operated and She Operates - Patient Dies
2. The Doctor Shouldn’t Have Operated and She Operates - Patient Dies
3. The Doctor Should Have Operated and She Operates - Patient Lives
4. The Doctor Shouldn’t Have Operated and She Operates - Patient Lives

We have decided that these outcomes should have different values so we made a comparison among them:

2 < 1 < 4 ≤ 3.

The values in the decision tree are chosen arbitrarily considering the comparison above.

b) Based on the decision tree, the best decision is to operate as soon as possible. The issue of waiting 12 hours is that the chances of the appendicitis digressing and turning into a perforated appendix rises significantly. Once the patient has a perforated appendix, the chance of death also rises significantly due to complications. The chance of death increases 20 times if you operate on a perforated appendix compared to operating in NSAP. Therefore, although the patient hates operations, the best decision is to operate now to avoid even more risk in the future.

**Problem 4:**

Please refer to our decision tree when reading our assumptions and analysis for question 4 in appendix 2. We first shall be making certain assumptions on the priorities of Captain Sandford.   
  
His first and foremost priority is the safety and well being of his crew and ship; therefore, decisions involving their safety is one he would not take likely. In addition, he is also focused on completing the mission which is to reach the Persian Gulf to pick up the 200,000 Gallons of Oil. Failure would cause a huge loss of income to his employers or even death and would have negative repercussions to the Goodwill of the company and its ability to deliver. We have made assumptions about Captain Stanford’s problem to balance out his priorities and weigh the risks of his actions:

1. Losing the rights to the ship happens only 5% of the time.
2. Assume the revenue of the payoff is pegged to the price of oil and the amount of oil being transported for the ship. Seeing that the ship will be carrying 200,000 tons of oil. This implies that there are 1513141 barrels of oil with each at $50 per barrel. Therefore, the entire profit payoff that could be reaped is $75657038.
3. If the ship sinks in bad weather or floats to the Indian ocean the cost to the company is $200,000,000. We have derived this figure through adding the value of the ship, the loss of goodwill, the loss of crew, and the loss of revenue from oil.
4. The cost of foundering in good weather is assumed to be $130,000,000.  The crew will be able to make it out alive unlike the previous scenario but the ship and potential oil revenue is lost.
5. If the ship drifts out into the ocean and no tug is available, it is assumed that the ship is destroyed along with all personnel.
6. Captain Stanford is acting in the best interest of the company; therefore, he desires to deliver the oil from the Persian Gulf despite the threatening circumstances.
7. The Captain can call a tug after the initial 30-minute time window in the first sign of trouble unless the tug is unavailable.

Therefore, we would recommend to the Captain should to move forward. After the decision to move forward, the fate of the ship is out of his hands and into the hands of God. The decision to move forward will result in higher expected return than immediately giving up; however, the decision can vary depending on your value of life. Since the Captain knows these men better than we do, he may wish to abort the mission. We can rephrase our response by stating, “There is a 3.9% we all die if we move forward,” which can impact the Captain’s decision. Nonetheless, based on the assumptions previously stated, we believe our best option is the option to carry on.