Problem:

A nuclear power company is deciding whether to build a nuclear power plant at Diablo Canyon or at Roy Rogers City. The cost of building the power plant is $10million at Diablo and $20 million at Roy Rogers City. If the company builds at Diablo, however, and an earthquake occurs at Diablo during the next five years, construction will be terminated and the company will lose $10 million (and will still have to build a power plant at Roy Rogers City). Without further expert information the company believes that there is a 20% chance that an earthquake will occur at Diablo during the next five years. For $1 million, a geologist can be hired to analyse the fault structure at Diablo Canyon. She will predict either that an earthquake will occur or that an earthquake will not occur. The geologist's past record indicates that she will predict an earthquake on 95% of the occasions for which an earthquake will occur and no earthquake on 90% of the occasions for which an earthquake will not occur. Should the power company hire the geologist?

(This Problem is due to Winston and Albright-Business Analytics)

Soln:

From the problem

P(E)=0.2

P(NE)=0.8

P(GPE|E)=0.95 => P(GNPE|E)=0.05

P(GNPE|NE)=0.9 => P(GPE|NE)=0.1

By Baye's theorem

P(E|GPE) = [P(GPE|E)*P(E)]/{ [P(GPE|E)*P(E)]+ [P(GPE|NE)*P(NE)]}

= [(0.95*0.2)/{(0.95*0.2)+ (0.1*0.8)}

= [0.19/(0.19+0.08)] = 0.19/0.27 = 0.704

P(NE|GPE) = [P(GPE|NE)*P(NE)]/{ [P(GPE|NE)*P(NE)]+ [P(GPE|E)*P(E)]}

= [(0.1*0.8)/{(0.1*0.8)+ (0.95*0.2)}

= [0.19/(0.19+0.08)] = 0.08/0.27 = 0.296

P(E|GNPE) = [P(GNPE|E)*P(E)]/{ [P(GNPE|E)*P(E)]+ [P(GNPE|NE)*P(NE)]}

= [(0.05*0.2)/{(0.05*0.2)+ (0.9*0.8)}

= [0.01/(0.01+0.72)] = 0.01/0.73 = 0.014

P(NE|GNPE) = [P(GNPE|NE)*P(NE)]/{ [P(GNPE|E)*P(NE)]+ [P(GNPE|E)*P(E)]}

= [(0.9*0.8)/{ (0.9*0.8)+ (0.05*0.2)}

= [0.72/(0.72+0.01)] = 0.72/0.73 = 0.986

P(GPE) = [P(E)*P(P(GPE|E))]+[P(NE)* P(P(GPE|NE))]

= 0.2*0.95+0.8*0.1

= 0.19+0.08 = 0.27

P(GPNE) = [P(E)*P(P(GNPE|E))]+[P(NE)* P(P(GNPE|NE))]

= 0.2*0.05+0.8*0.9

= 0.01+0.72 = 0.73

Decision:

Numbers speak for themselves, **we should be hiring a geologist** to mitigate the risk that might/might not be incurred due to earthquake losses. Please note these analysis is based on probability concepts and gives approximate figures only, this data will be accruing details for decision making but not sole reason for deciding whether to hire geologist or not. The analysis is on new nuclear plant, whether the company should decide on building in Diablo Canyon or Roy Rogers City, and also to hire a geologist to predict earthquakes at Diablo. Following are the details:

- Following this plan would cost the company an expected amount of $13.9 million dollars vs to that of going with 80:20 prediction that would incur $14 Million.
- Hiring a geologist will cost to company
    - If Diablo
        - $11 million if earthquake don't happen
        - $31 million if earthquake happens
    - If Roy Rogers City it would cost $21 million
    - If the geologist predicts that an earthquake will occur, the company should build the plant at Roy Rogers.
    - If the geologist predicts earthquake will not occur, the company should build the plant at Diablo.

Reference:

Analysis whiteboard is captured below as decision tree: