

Decision Analysis with Decision Trees

By Susan Miertschin

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Decision Analysis with Decision Trees

From: C. W. Kirkwood, [Decision Tree Primer](#), 2002

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Problem 1 - Where Should PhonyTalk Put R&D \$\$\$?

- PhonyTalk is considering introducing one of 2 products into the market, a high end multimedia mobile phone (mPhone) or a low end basic mobile phone (BasicPhone). The R&D costs for the mPhone is \$100,000 and BasicPhone is \$10,000. The phones are expected to stay on the market for one year with the expectation that the mPhone would gross profits of \$1 million in that year while the BasicPhone would gross profits of \$400,000 during that year. The chance of getting the mPhone designed and produced successfully in the time allotted is 50%. The chance of getting the BasicPhone designed and produced successfully in the time allotted (same as for mPhone) is 80%.
- Which product should PhonyTalk introduce?

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Use a Decision Tree to Analyze Alternatives

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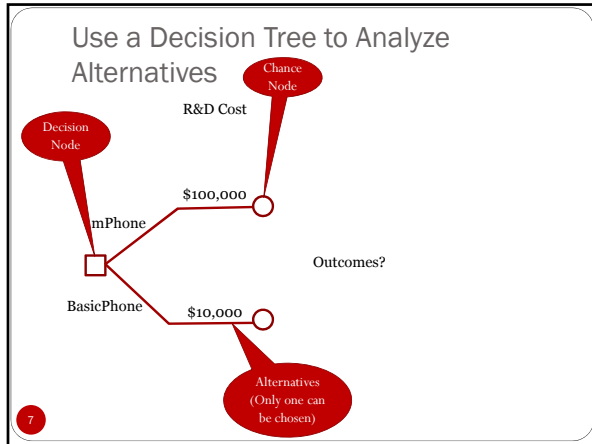
Use a Decision Tree to Analyze Alternatives

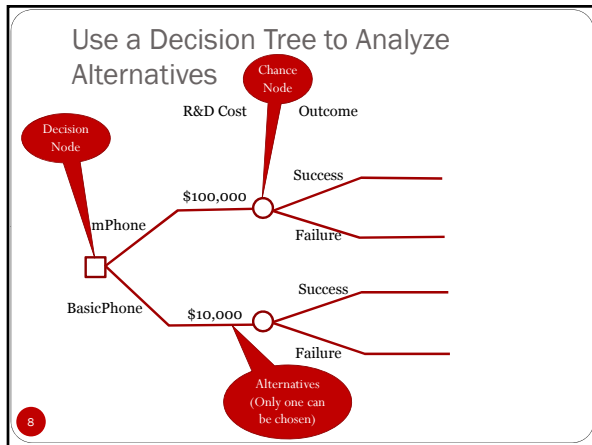
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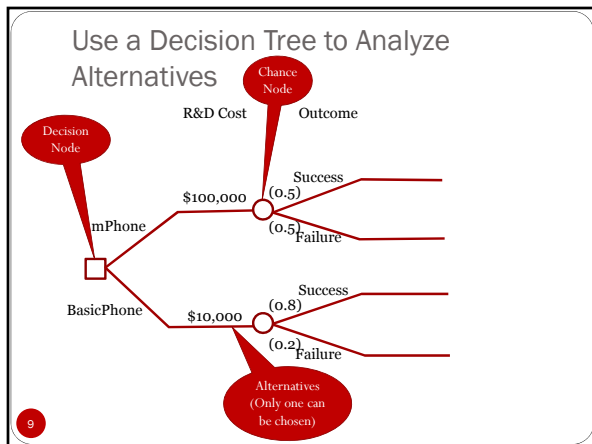
Use a Decision Tree to Analyze Alternatives

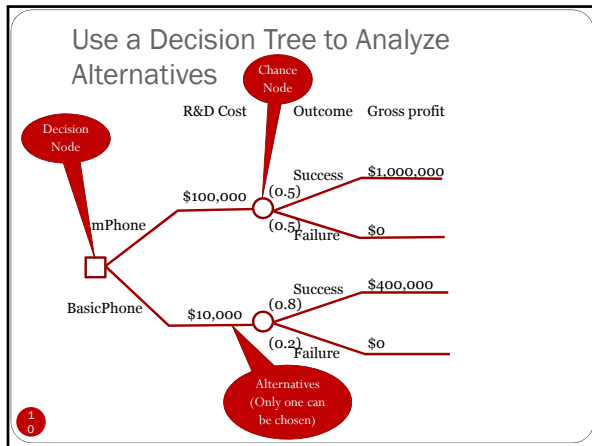
R&D Cost

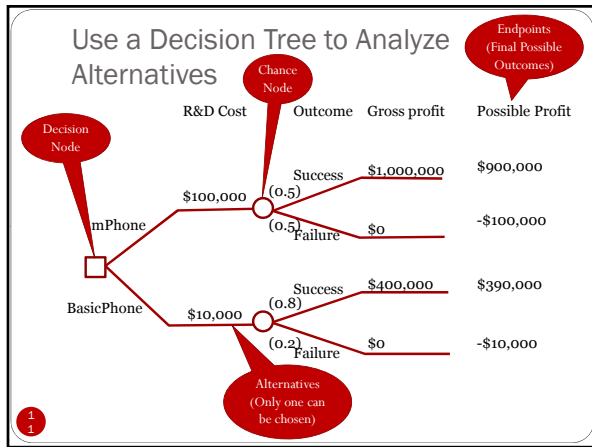
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What to Do?

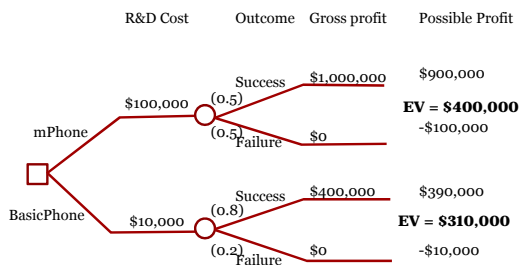
What to Do?

Expected Value

- Expected value is calculated by multiplying each outcome with the probability of that outcome
- In expected value decision criteria, select the alternative that has the maximum expected value
- Expected Values
 - $EV(\text{mPhone}) = 0.5 \times 900,000 + 0.5 \times (-100,000) = \$400,000$
 - $EV(\text{BasicPhone}) = 0.8 \times 390,000 + 0.2 \times (-10,000) = \$310,000$

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Use a Decision Tree to Analyze Alternatives



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Decision Tree

- A decision tree can have more than 2 chance nodes as well as hierarchies of chance nodes
- Further reading
 - C. W. Kirkwood, [Decision Tree Primer](http://www.public.asu.edu/~kirkwood/DASstuff/decisiontrees/index.html), 2002. (<http://www.public.asu.edu/~kirkwood/DASstuff/decisiontrees/index.html>)

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Problem 2 – What Should Rachel Do?

- Rachel is planning a party. She needs to decide whether to have the party outdoors or indoors. She prefers to have the party outdoors if it is sunny and not too hot, but indoors if it is raining or too hot.
- Rachel assigns a “profit” of 1 to the best possible outcome in her mind, which is “the party is outside on a beautiful sunny day with highs in the 70s”. To the worst-case scenario she assigns a “profit” of 0 and that event is “the party is outside and it is raining and/or temperatures sore”. To two intermediate scenarios, Rachel assigns “profits” between 0 and 1. To “the party is inside on a beautiful sunny day with highs in the 70s” she assigns 0.4. To “the party is inside and it is raining and/or temperatures sore” she assigns 0.7.
- The almanac says that for past 20 years, during the week when the party is to be held, it has rained on 30% of the days.
- Should Rachel plan for an indoor or outdoor party?

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Problem 3 – What Should Mr. Peters Decide?

- Mr. Peters was recently diagnosed with colon cancer. His oncologist thinks that he should be treated surgically due to the particular type of cancer and its location. The result of surgery is that Mr. Peters will have to wear and use a colostomy bag for the rest of his life. With this treatment option (surgery), Mr. Peters has a 90% chance of a complete cure, a 1% chance of death during the surgical procedure, and a 9% chance of cancer recurrence within 5 years.
- Mr. Peters gets a second opinion. The second doctor thinks radiology plus chemotherapy would have a 75% chance of curing him completely with a 25% chance of recurrence within 5 years.
- If recurrence happens, then there is 50% chance that the condition will be considered terminal with no treatment options and there is also a 50% chance that the condition will still be considered curable with whatever treatment options are available.
- As Mr. Peters struggles with these complex decision options, he gets help from some online decision support tools which help him assign utility values to different outcomes. He places a value of 0 on “death” as an outcome. He places a value of 0.92 on “health with a colostomy bag”. He places a value of 1 on “health with no colostomy bag”. There is one more outcome possible that Mr. Peters learns he has to value and that is “health after a recurrence of the disease which will be draining, expensive and painful”, and on that outcome he places a value of 0.75.
- What should Mr. Peters decide?

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Problem 4 – What Policy Should a Web Retailer Choose?

- A web-based retailer is considering insurance against a possible denial of service (DoS) attack. The daily sales of the retailer are about \$20,000. Research statistics show that there is a 0.03 probability that the web retailer may suffer a denial of service attack. In the event of the attack, the loss in sales would be 10%, 20% or 40% of sales with probabilities of 0.5, 0.35, and 0.15. The web retailer has 3 options
- Policy A costs \$150 a year but guarantees to cover any loss due to a DoS attack.
- Policy B costs \$100 a year with a \$50 deductible.
- Policy C costs \$75 but covers only 40% of the loss.
- Assume that only 1 DoS attack can take place in a year.
- What policy should the web-based retailer choose?

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