Games Against Nature: Decision Making Under Uncertainty — Evaluation

Today's topics:

1. Why Use an Influence Diagram?
2. Influence Diagram Exercises
3. Case 1a: Decision Trees
4. Probability
5. Case 2: Laura's Decision
6. The Certain Equivalent
7. Gaining Insight — next lecture
   - Deterministic evaluation — the Tornado Diagram
   - Probabilistic evaluation.
   - The value of information.

1. Why Use An Influence Diagram?

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- Develop the logic and structure for the computer decision model.

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Step 4: **What piece(s) of information would most help in resolving the uncertainty or determining the value?**

Procedure (cont.)

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Make sure the nodes are clearly defined and specific.

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Step 11: Write an information-gathering task list.

2. Influence Diagram Exercises

1. Nuptials
   a. Who is the decision maker?
   b. What are the values?
   c. What are the uncertainties that influence events/values/decisions after the first decision?

2. Texaco versus Pennzoil

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Types of Influence Diagrams

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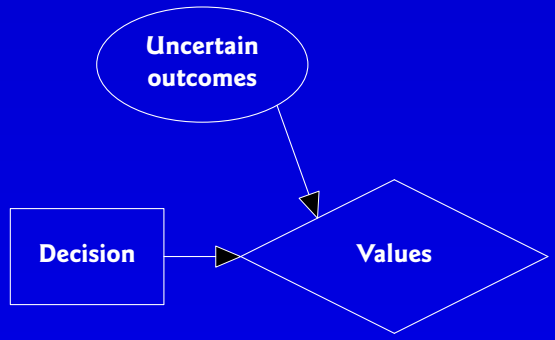

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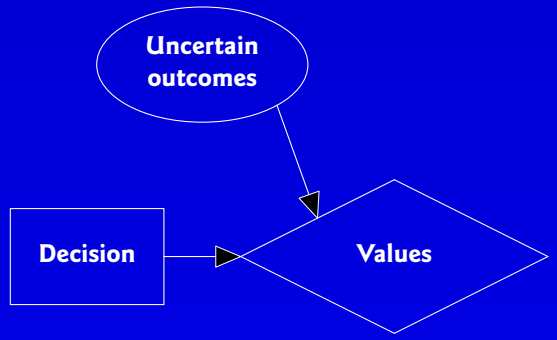
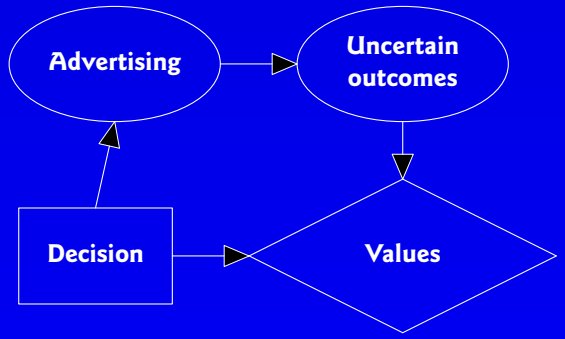


2. Decision influences the probabilities. (e.g. advertising)



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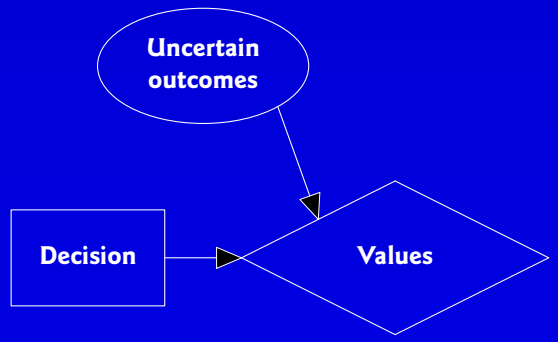

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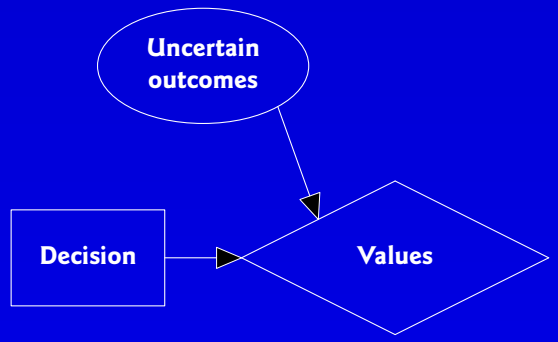
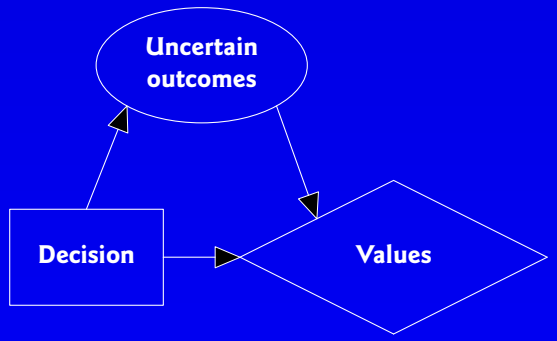


4. **Incentives: moral hazard with insurance**
   (i.e. less care about locking up the house if 100% insured against theft.)



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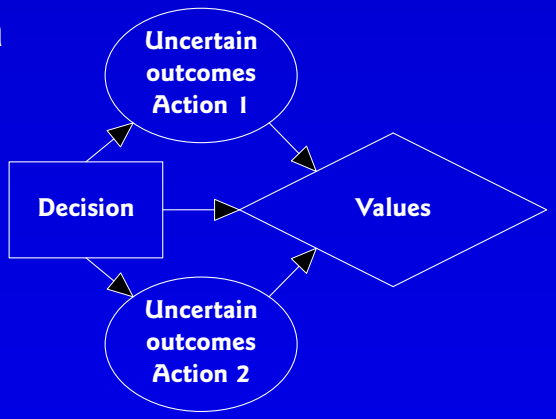

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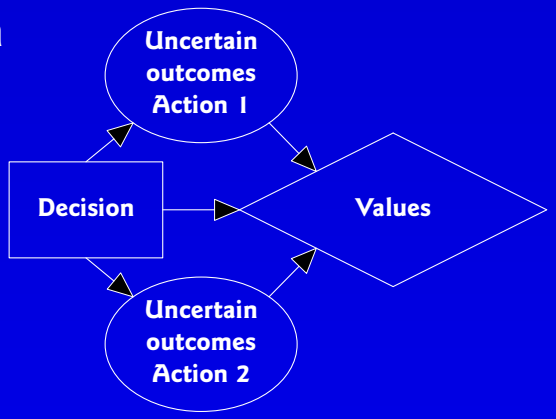
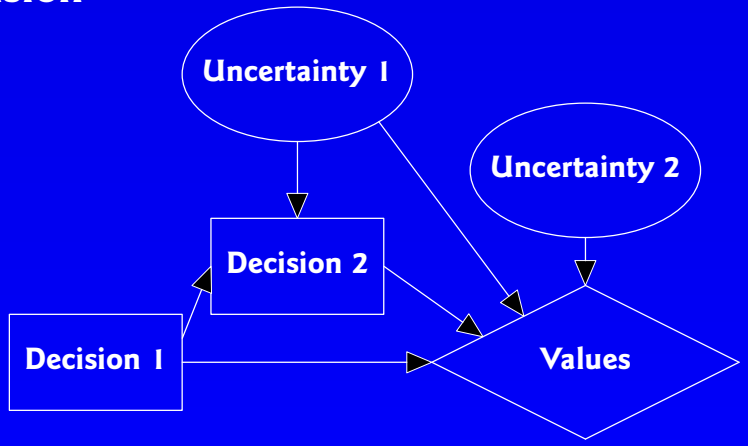


6. **Two-stage decision (e.g. Pennzoil)**



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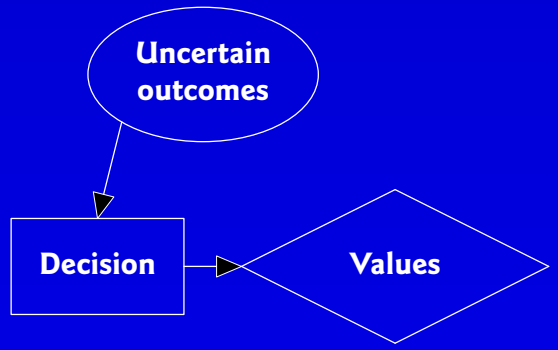

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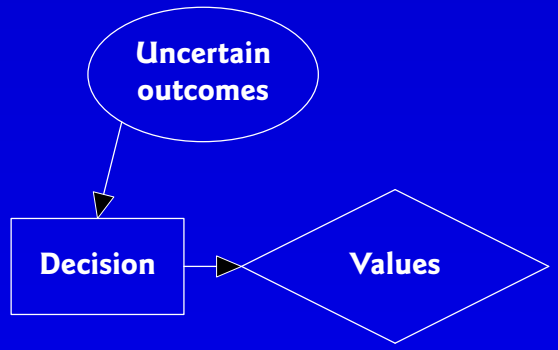

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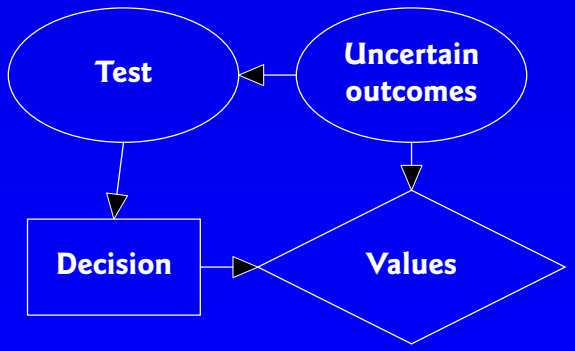
8. Value of Imperfect Information (Compare the EV of 8. — less than the EV of 7. — with the EV of 1. (e.g. test marketing, forecasting)



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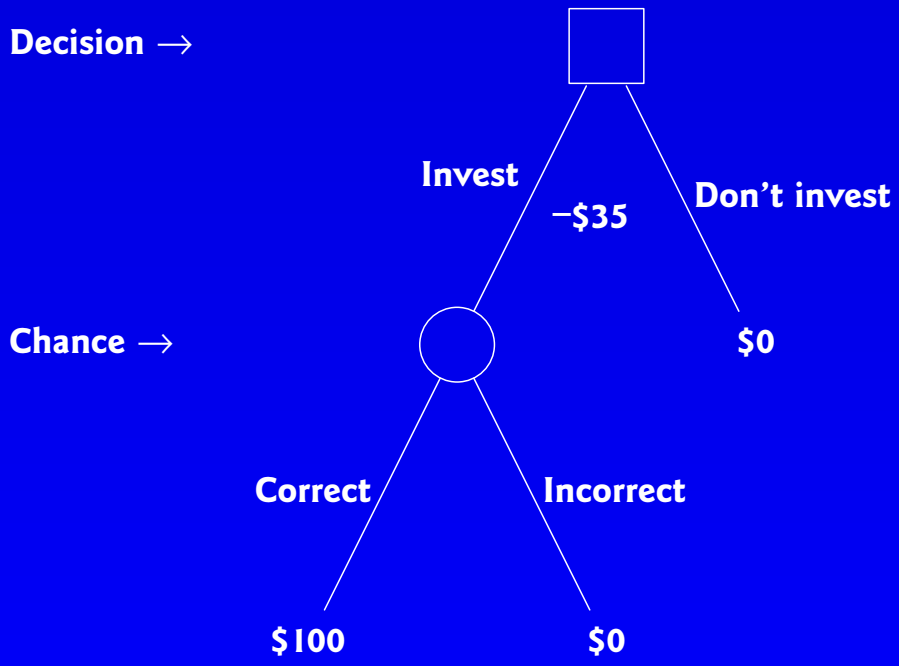
Whether or not to invest $35 for the opportunity to receive $100 or $0 as the outcome on the call of a die roll as odd or even.



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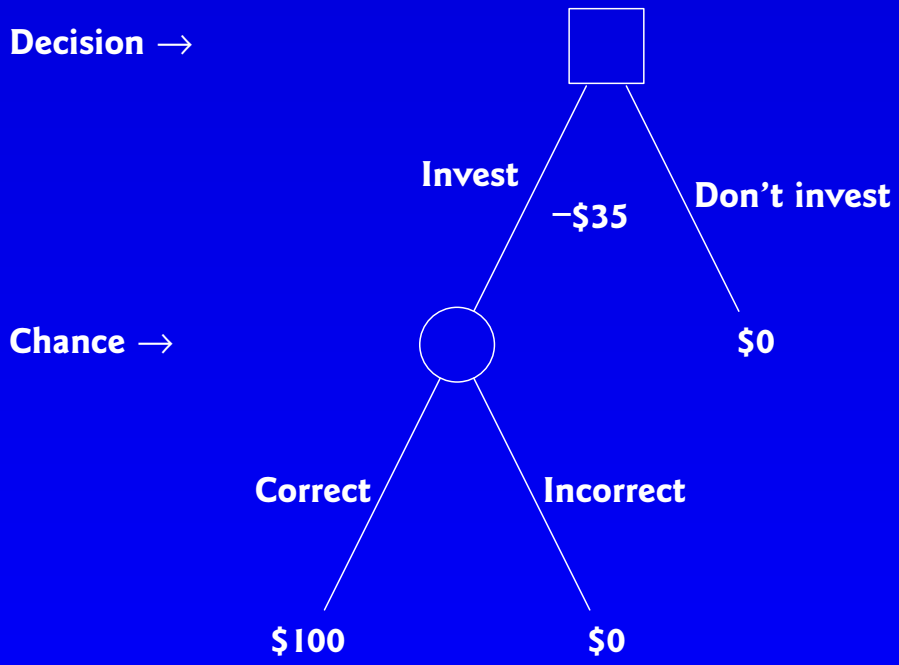

What else is needed to evaluate this opportunity?

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Flow diagrams showing the logical structure of a decision problem.

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- ***Probabilities*** **for each possible outcome of a chance event.**

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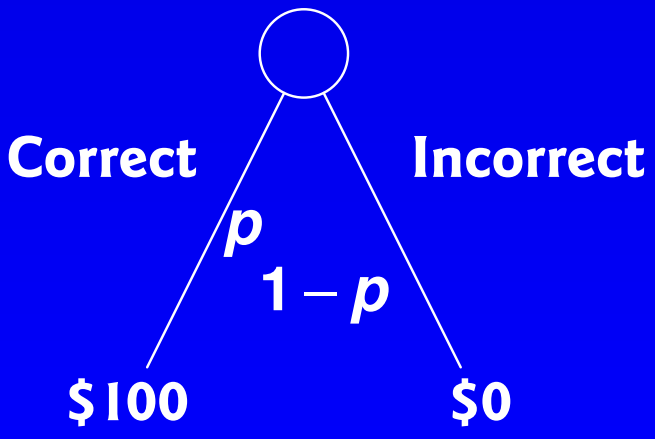

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Provides a means of assessing situations where something has either never occurred or is a rare event, or you have no information on past occurrences.

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We all form subjective probabilities of events all the time (driving, playing, working, at home).

The distinction between objective and subjective probability:

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Probabilities obtained from experts, based on their knowledge, experience, beliefs, and data, are considered *subjective*. Most decisions require subjective probabilities.

- Market acceptance of a new product.
- Probability of the Swans reaching next season's Grand Final.
- Probability of Latvia's bankruptcy?

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- There is an 80% chance of rain tonight [Canberra]

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A: No more than the higher profits it could earn by taking advantage of the information.

Other Uncertainties Facing Managers:

Apart from the weather, in their "games against Nature" managers are concerned about such uncertainties as:

- the future demand for a particular product
- the cost and reliability of untried technology
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Moral: There are no payoffs for spending more time and money to obtain more information than you really need.

Using probabilistic statements of uncertainty

Consider the following four sentences:

It could happen	_____
It might happen	_____
I think it will happen	_____
I'm sure it will happen	_____

On each line to the right of the sentence, write down your assessment of the likelihood of happening. Write down a *single number*, the midpoint of your range.

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Take-away?

An Example of Subjective Probability.

You are shown a dictionary containing over 1,400 pages of information.

What is the probability that the first new word on page 1025 begins with the letter Q?
(This experiment can be run only once.)

Write your probability here _____.

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States of knowledge

Subjective (Bayesian) probabilities rely upon expert knowledge which is always changing as new information becomes available. So probabilities should also change as new information becomes available.

Helpful hints (i.e. new information):

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Is your probability assessment correct?

Assessing Uncertainty

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Finding the Right Experts:

An expert is like an onion.

You can peel away layers of information, with each new layer revealing more depth and breadth of information about the event.

When there is no further information, a *true* expert tells you, and does not continue commenting.

Assessing Uncertainty:

Probability provides a language to communicate, in an unambiguous manner, one's beliefs about future events.

We need the ability to elicit subjective assessments from experts.

One device for doing so is the Probability Wheel.

The Subjective Probability Wheel

Encode your subjective probability of a specific event: e.g. of sales volume exceeding $*XXX* this year.

1. **Imagine the colour wheel spinning so fast that the colours seem to blend completely.**
2. **Now ask which you would rather bet on: that the event occurs (sales exceed $*XXX*), or that the throw of a dart hits yellow rather than blue.**
3. **If you prefer to bet on the event's occurring, increase the yellow area. If you prefer to take your chances on the dart's hitting yellow, reduce the yellow area.**
4. **Continue adjusting the areas until you are *indifferent* between the two bets.**
5. **Read your subjective probability of the event from the back of the Wheel.**

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When we assess an expert, we want to obtain at least three points in order to adequately describe the curve or distribution.

We do this by gathering a "10–50–90".

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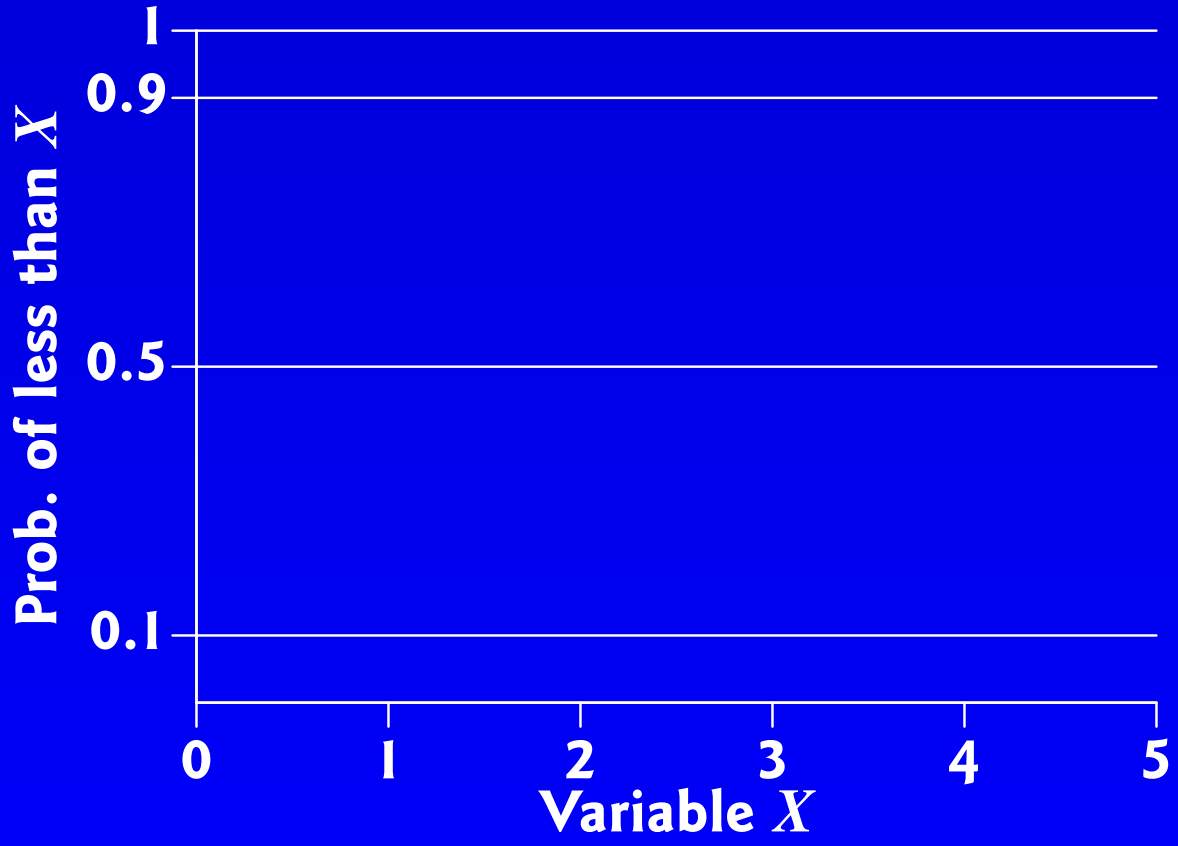
The 10 point is a 1-in-10 chance that the assessed value could be that low or lower.

The 50 point is where the expert is indifferent: the event could equally be above or below the 50 point.

The 90 point is a 1-in-10 chance that the assessed value could be that high or higher.

Plotting the distribution.



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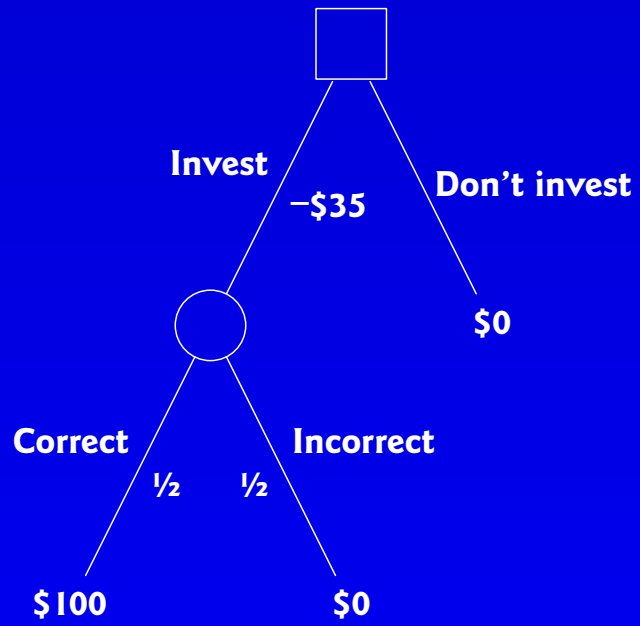
Either way, there is a six-step process:

A Six-Step Process of Eliciting Probabilities

1. Motivate the expert
2. Structure (definition, measure) the questions
3. Condition against framing (counter cognitive biases)
4. Encode the probability (use Probability Wheel, plot, review discrepancies)
5. Verify the answers (does the expert believe the assessment?)
6. Make discrete rather than continuous (for a small number of alternatives)

EMV (Expected Monetary Value) is the probability-weighted average:



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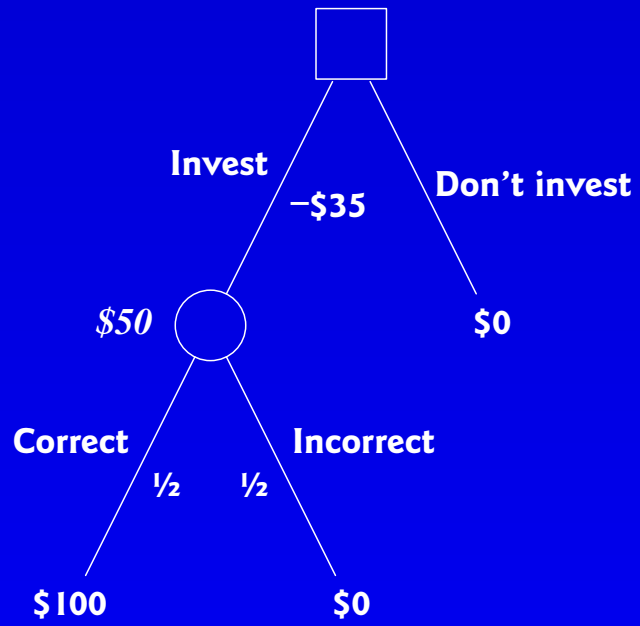

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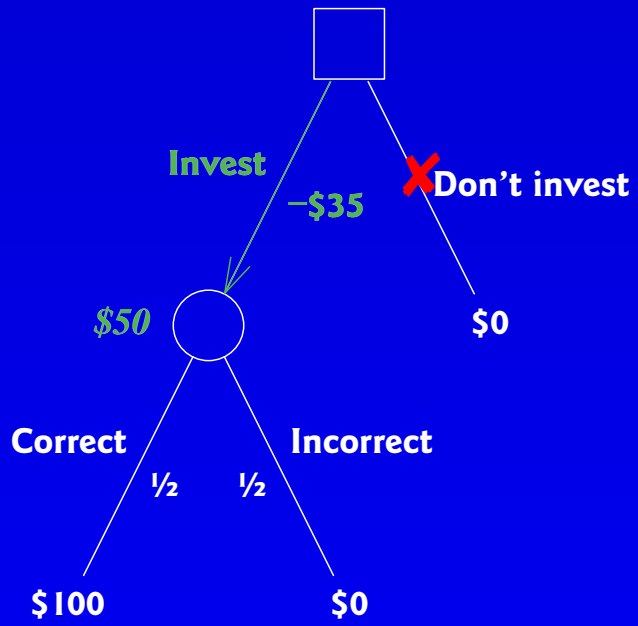

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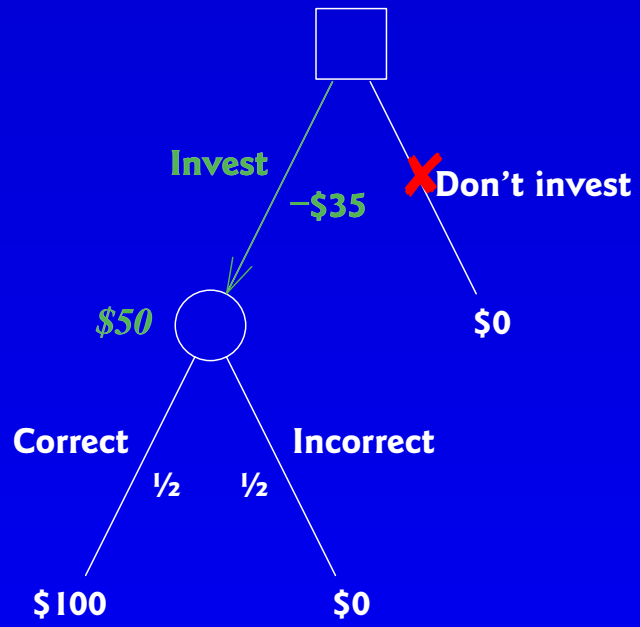

Probability		Outcome		EMV
0.50	×	$100	=	$50
0.50	×	$0	=	$0
		EMV	=	$50
		Investment	=	−$35
		Expected Net Profit	=	$15

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You believe the probabilities of success or failure are equal, or 50:50.

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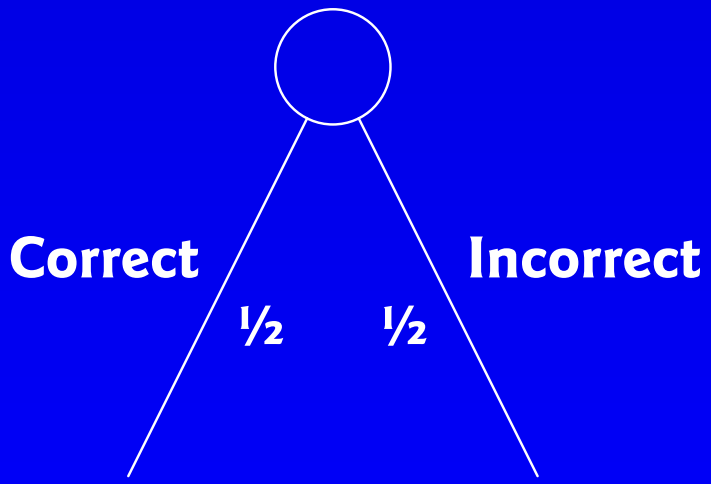

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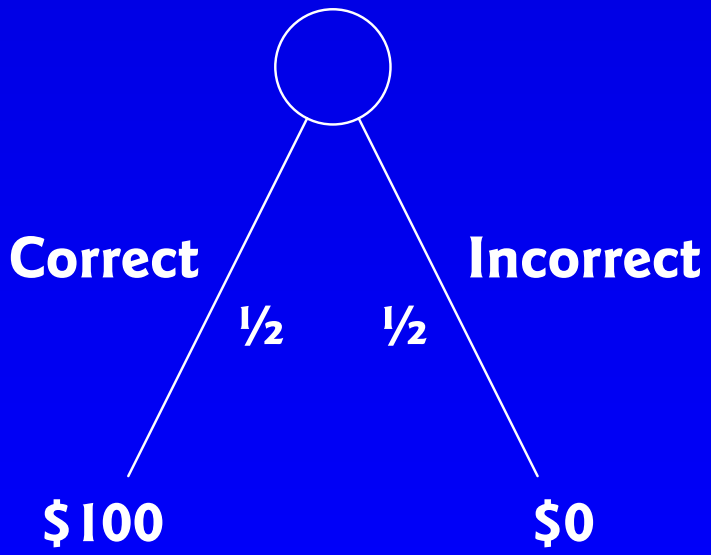

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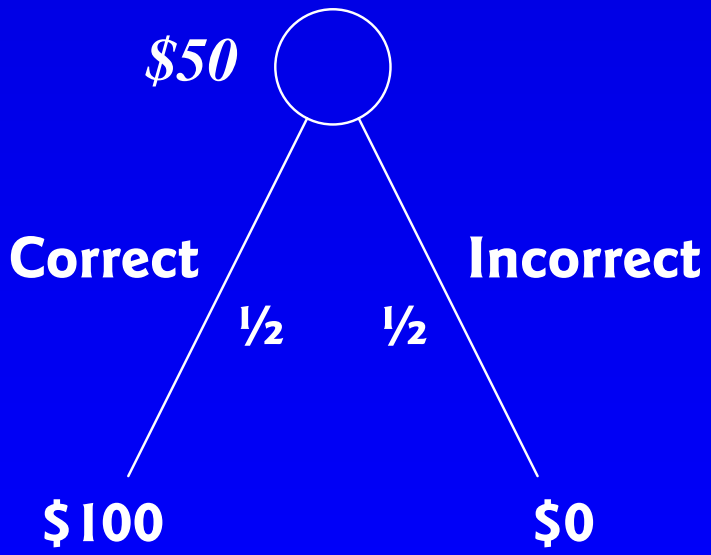

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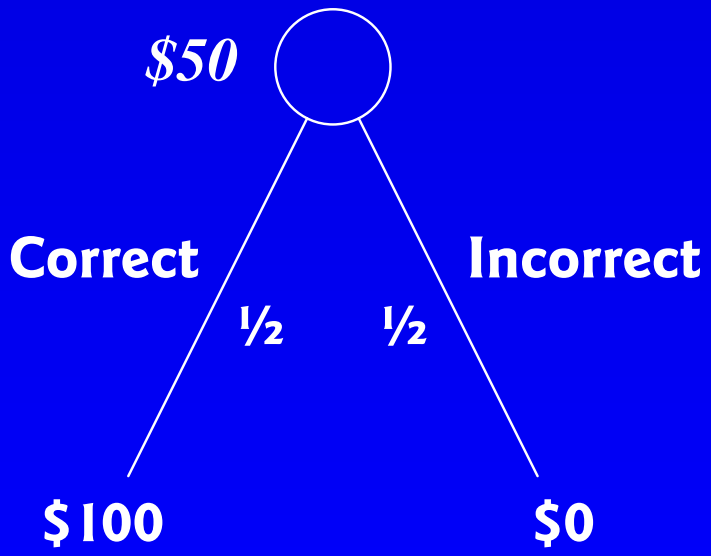

How has the opportunity changed?

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Evaluate future decisions for what they are worth.

The value you place on the future investment opportunity should not depend on costs already sunk.

5. Case 2. Laura's Shoe Decision

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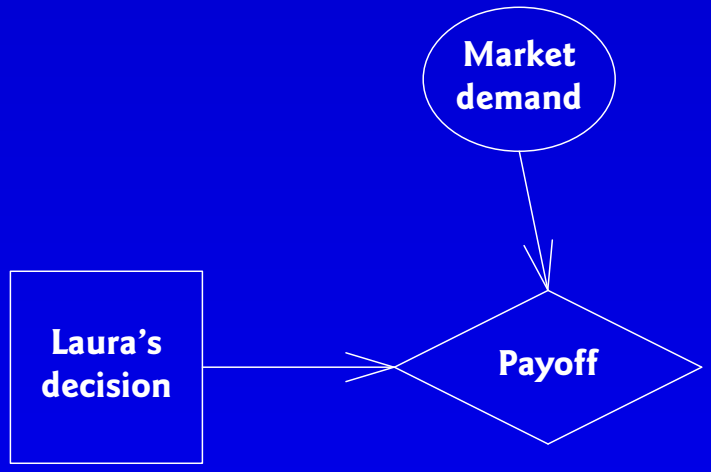
  - Laura believes that the *probability* of success of Retro is only 0.4,
  - ∴ with a probability of 0.6 it'll fizzle.

The *influence diagram* for Laura's decision:



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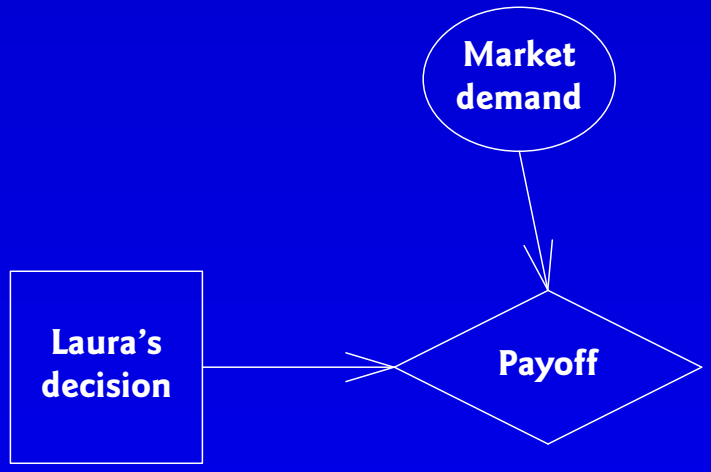

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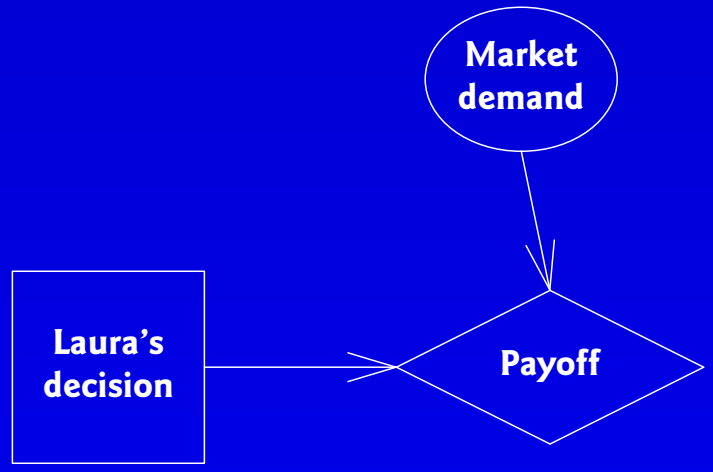

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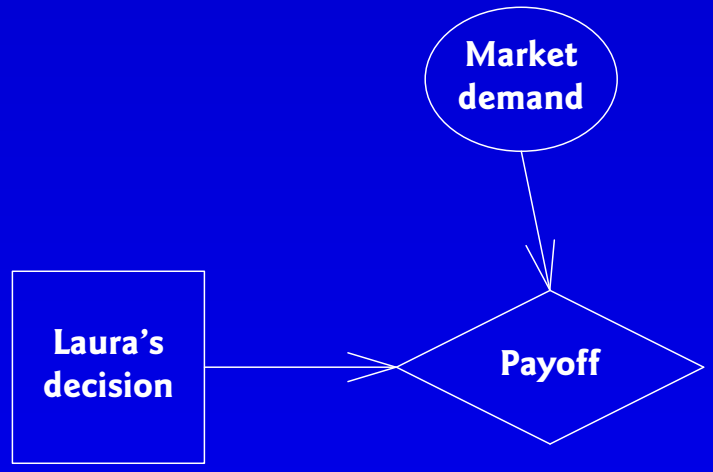

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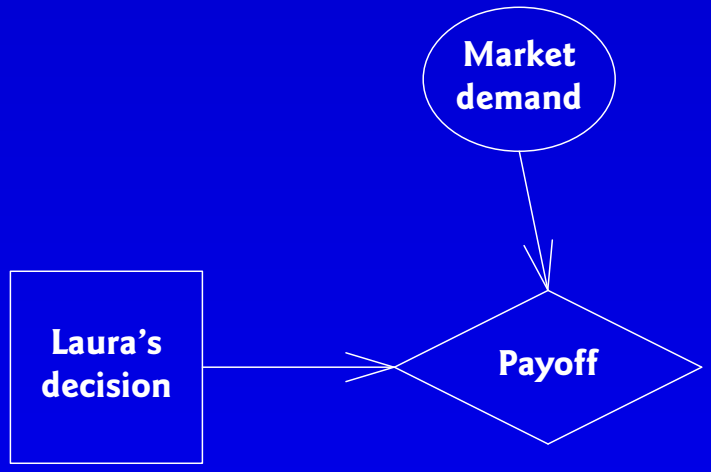

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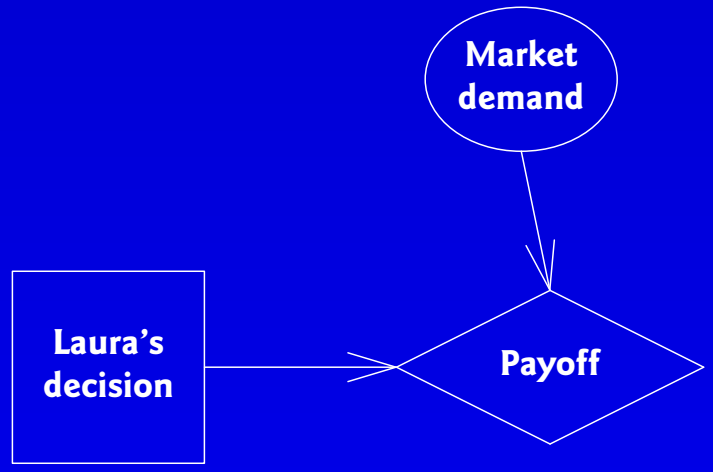

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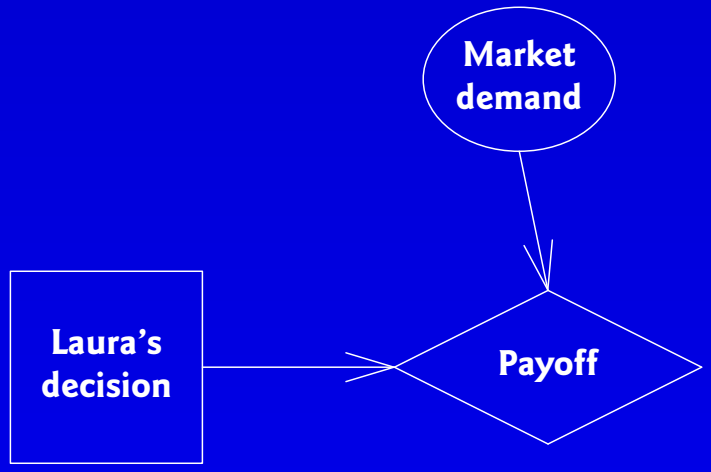

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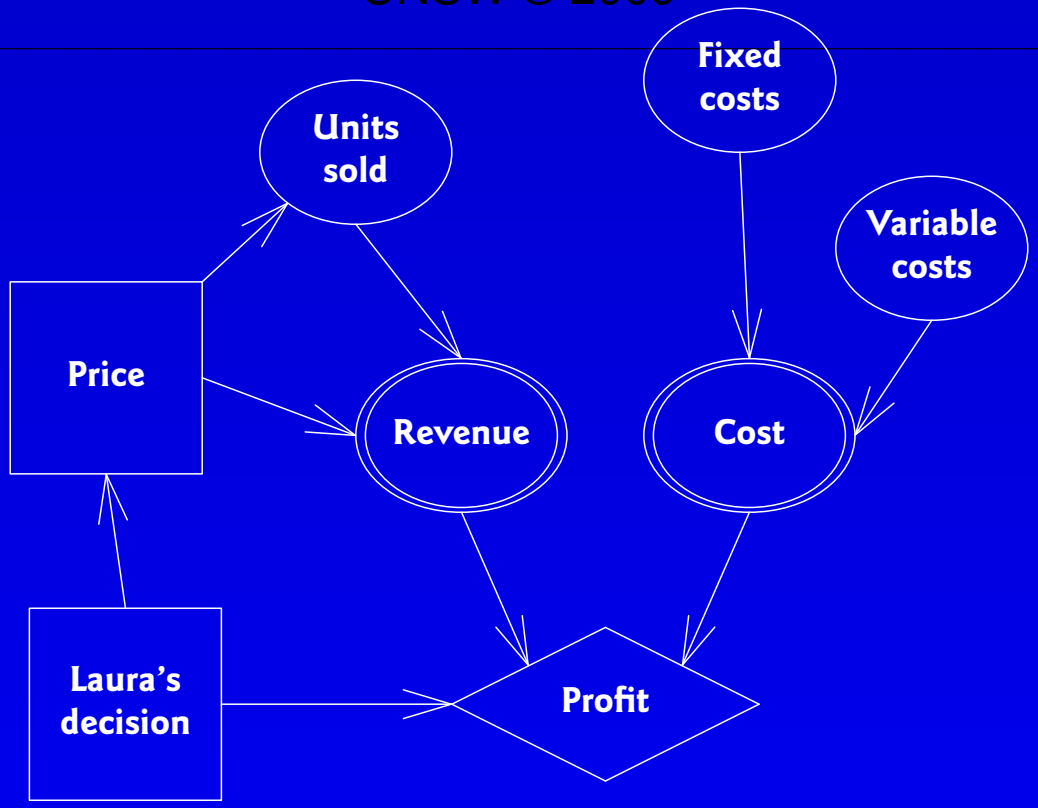
- Other lines, with different expected costs, revenues, and $\therefore$ different net returns.

Laura's ID


Fixed costs
Units sold
Variable costs
Price
Revenue
Cost
Laura's decision
Profit

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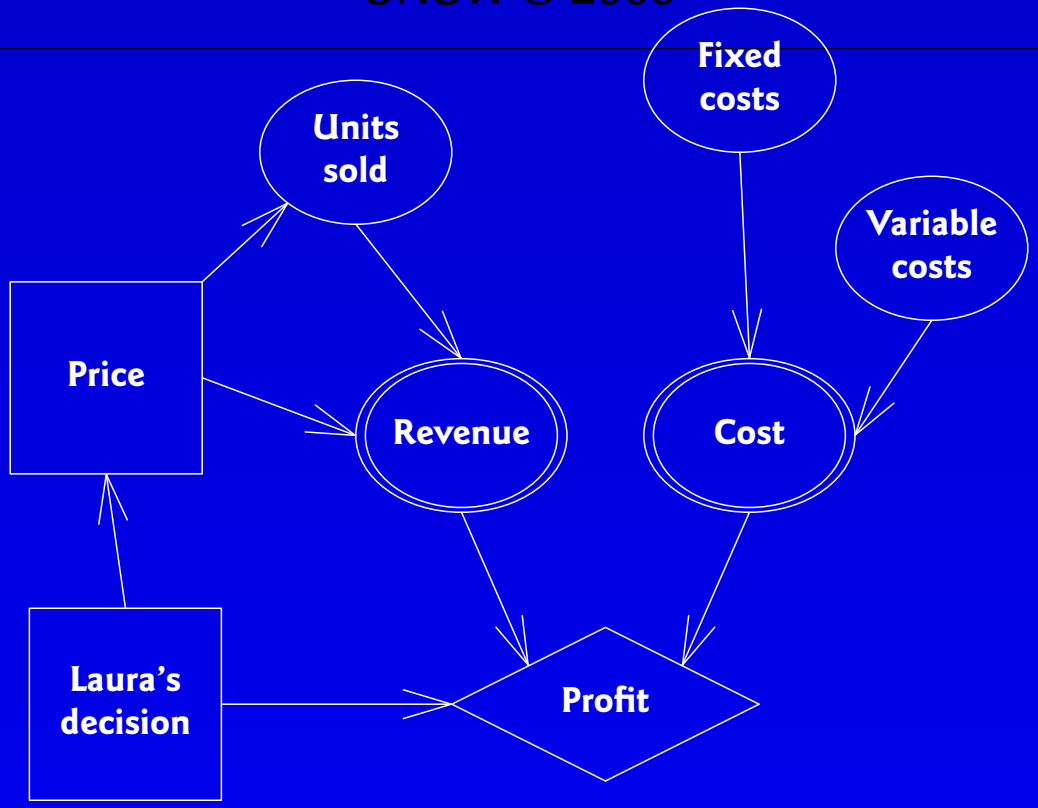

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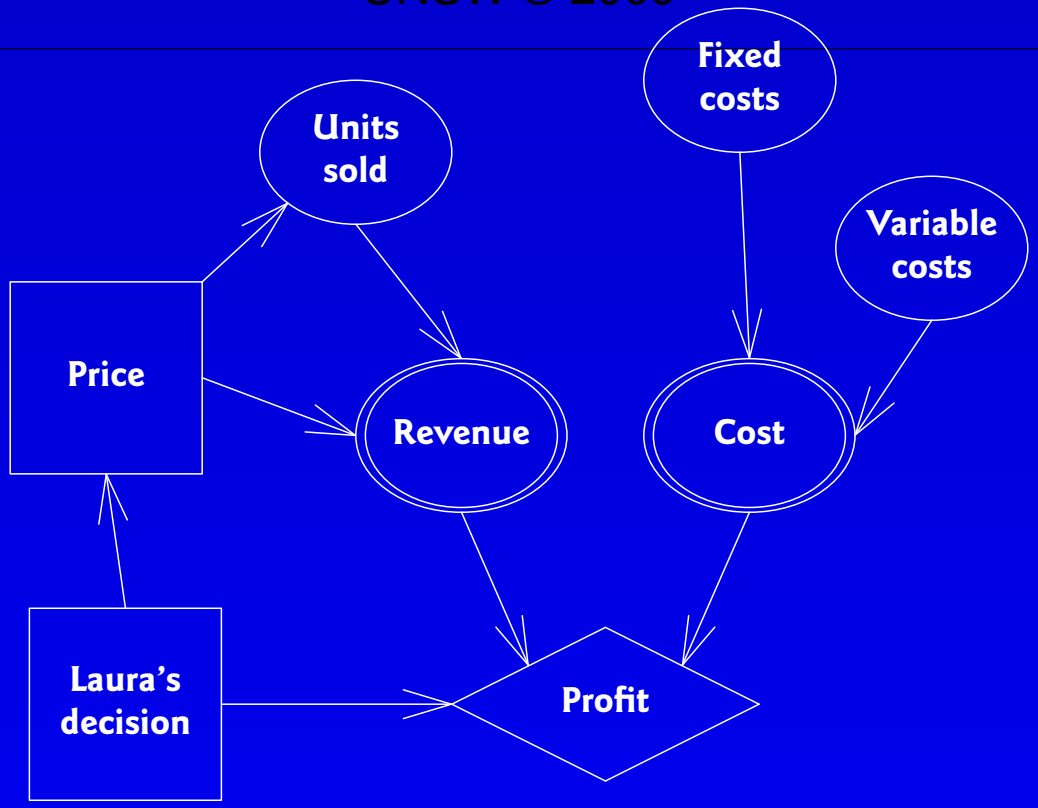

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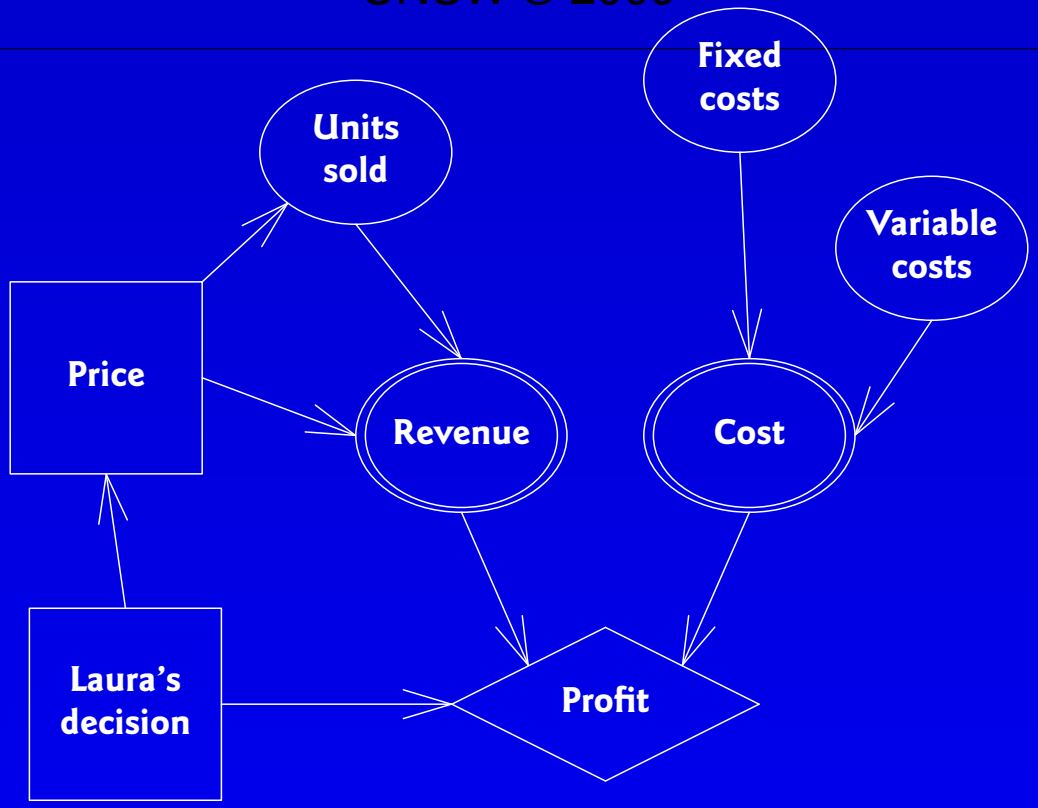

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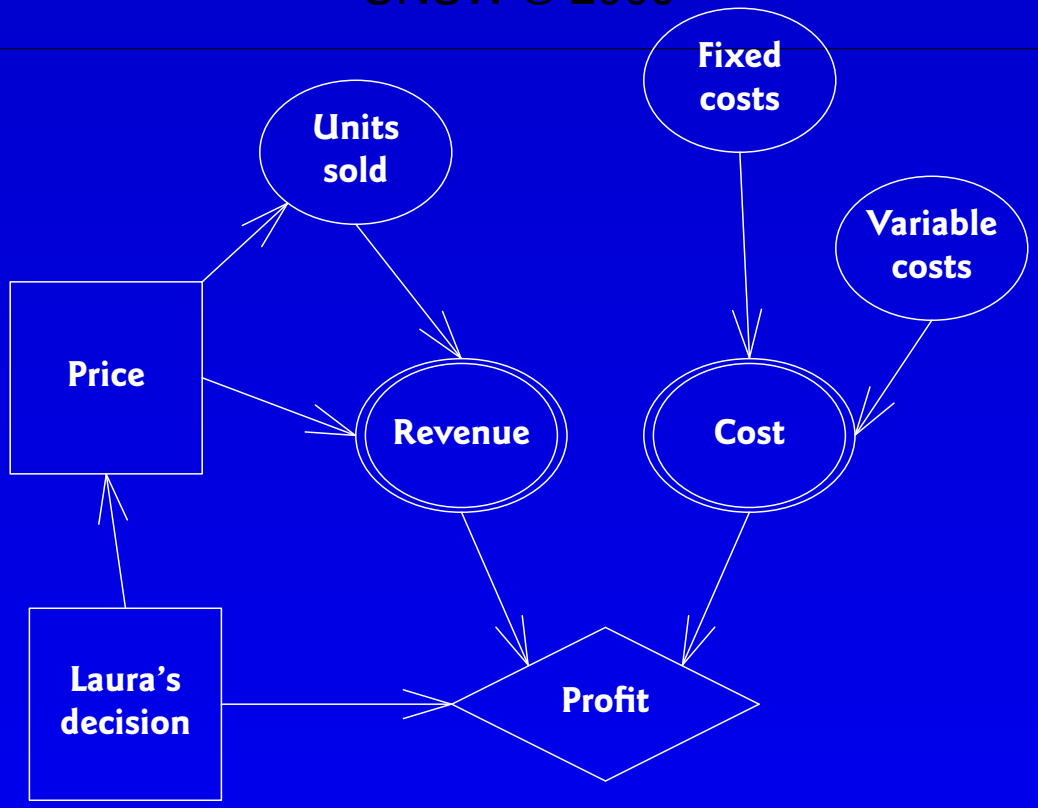

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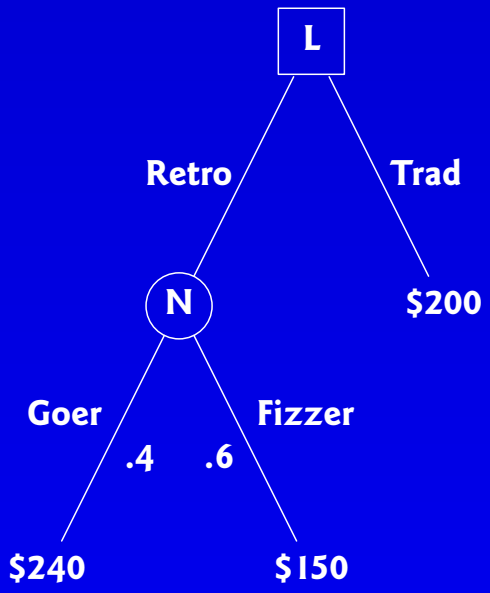
Laura's Decision Tree



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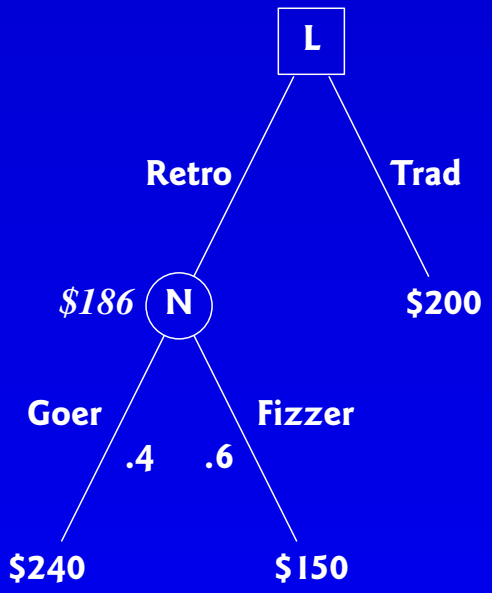

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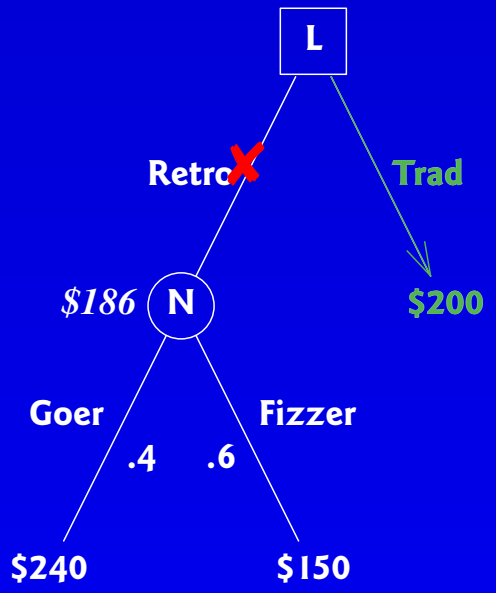
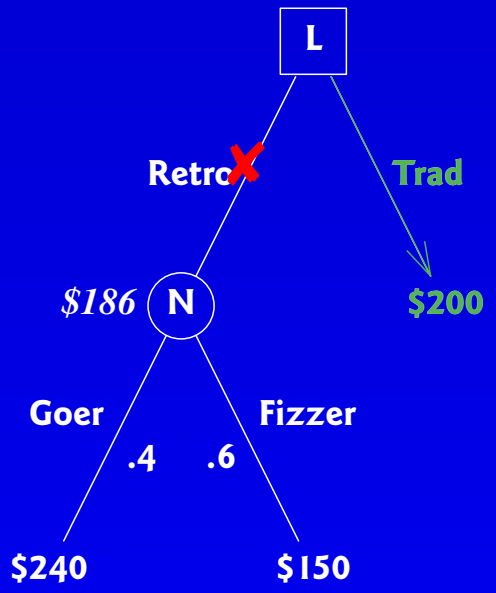


With the payoffs and probabilities, Laura can calculate:

- **the long-run, expected return of Retro, the payoffs weighted by the probabilities:**

  $240k × 0.4 + $150k × 0.6 = $186k.

Laura's Decision Tree



With the payoffs and probabilities, Laura can calculate:

- **the long-run, expected return of Retro, the payoffs weighted by the probabilities:**

  $$\$240k \times 0.4 + \$150k \times 0.6 = \$186k.$$

- **which is less than the certain return of $200k for Trad.**

Laura's decision?

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A risk-neutral or risk-averse decision maker (see later) would opt for Trad.

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➢

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-

Laura's decision?

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With a complex decision, a risk-neutral decision maker will choose:

- the action associated with *the maximum expected return* at every stage of a complex decision,
- allows us to "prune" branches on the decision tree associated with sub-maximal expected returns.

6. The Certain Equivalent

A better evaluation technique is the *Certain Equivalent*

The Certain Equivalent allows for inclusion of both *risk* and *time value* of money separately.

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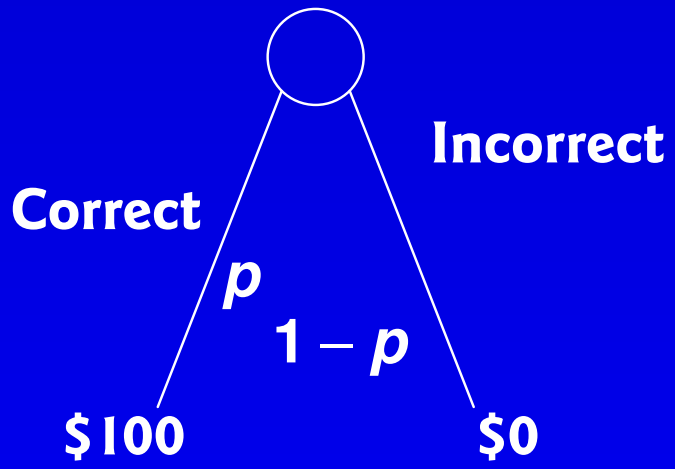
The Certain Equivalent of a deal is when the investor is indifferent between a deal with at least two opportunities and a guaranteed sum of money — also know as the investor's minimum selling price.

The Certain Equivalent of a lottery.



= $_____

a deal or opportunity = its Certain Equivalent