2. Decision Analysis: Games Against Nature

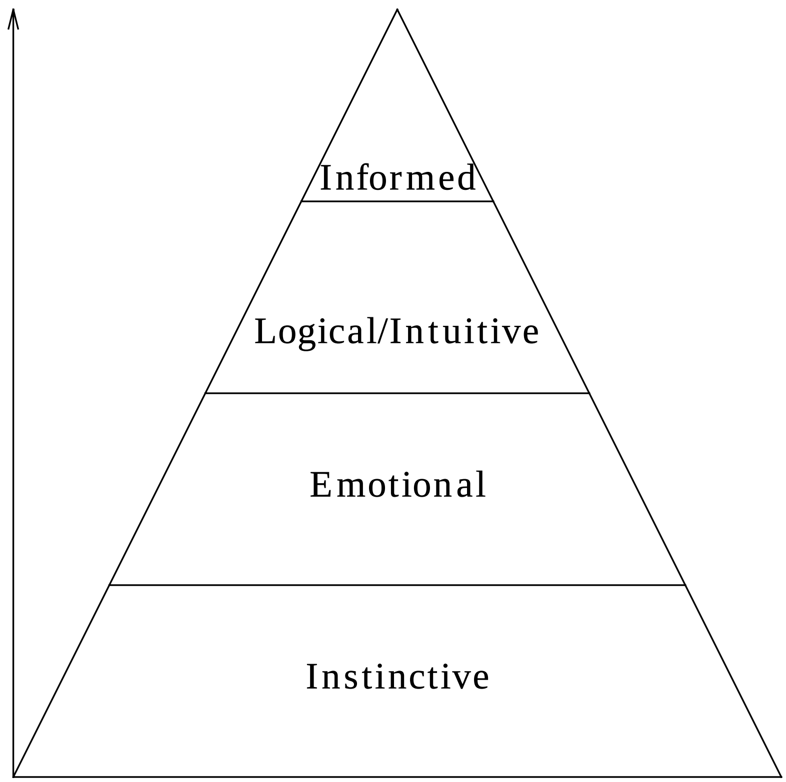
2.1 Basic Concepts

A technique for helping make decisions, and avoiding pitfalls.

We discuss:

- ➢ Formulating the issue.
- ➢ Identifying the alternative actions.
- ➢ Valuing the possible outcomes.
  (Not merely in monetary terms.)
- ➢ Encoding uncertainty.
  → probabilities
- ➢ Certain equivalent (C.E.).
- ➢ The value of perfect information.
- ➢ The value of imperfect information.
- ➢ Utility and risk aversion.
  The utility of a lottery is its expected utility

2.2 The Decision Response Hierarchy



Moving up the hierarchy corresponds to increasing consciousness, clarity, and power.

Which response do you use most often in making decisions?

- ☐ Informed
- ☐ Logical or Intuitive
- ☐ Emotional
- ☐ Instinctive

2.3 Why Is Decision-Making Difficult?

➢ Uncertain consequences or outcomes.

➢ Conflicting objectives

➢ Competing projects or alternatives

➢ Being held accountable for outcomes

➢ Multiple decision makers

➢ Risk attitude

Decision Analysis Addresses These Issues By:

➢ Focussing on what *don't know* rather than refining what you already knew.

➢ Applying a logically correct methodology to consistently evaluate alternatives

➢ Gaining insight into the decision problem

— the numbers should always be subservient to the insights gained.

2.4 What Is Decision Analysis?

Decision analysis **is**:

> A methodology based on a set of probabilistic frameworks which facilitates high-quality, logical discussions, leading to clear and compelling actions by the decision maker.
>
> — insights, not just numbers.

Decision analysis is **not**:

— A method for justifying decisions already made.

— Cost-benefit analysis

— A cookbook

Decision analysis provides answers to questions such as:

➢ How risky is this project?

➢ Which plan do we follow?

➢ Which assumptions are most important?

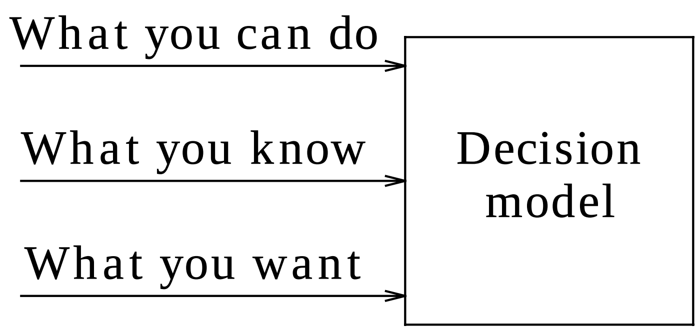
➢ What is the project's potential?

➢ Should we gather more data?

Beginning Principles:

The best you can do is to integrate in a logical manner:

- ➢ What you *can* do.
- ➢ What you *know*.
- ➢ What you *want* or *value*.



2.5 The Decision Analysis Process.

Decision analysis is a three-stage, quality process. But if at any step in the process the decision becomes obvious, you should stop and make the decision.

1. *Structuring:* Frame the Right Problem
   - ➢ Clarify the decision.
   - ➢ Raise and sort issues.
   - ➢ Generate creative alternatives.
   - ➢ Model the problem.

2. *Evaluation:* Use Logical Thinking
   - ➢ Discover what is important.
   - ➢ Apply an appropriate risk attitude.
   - ➢ Determine the value of new information.

3. *Agreement:* Have Commitment to Action
   - ➢ Check for refinement.
   - ➢ Agree on course of action.
   - ➢ Implement course of action.

Decision analysis is a normative process.

The term *decision analysis* is becoming a broadly used term in many industries. While it can be used *descriptively*, here we use the *normative* meaning.

Descriptive decision analysis is a present-state approach, describing how things *are*.

Normative decision analysis is a future-state approach, describing how things *should be*.

Why Decision Analysis?

- ➢ *Decision making* is at the heart of most technical, business and governmental problems, not to mention one's private life.
- ➢ Decision making requires the study of *uncertainty*. There are no sure things; risk-taking is inescapable.
  - — How does uncertainty affect decision-making?
  - — How can one make a rational decision (a "good" decision) without knowing exactly what consequences will follow?
- ➢ Think of risk-taking in terms of gambles or lotteries. Uncertainty can only be studied formally through *probability* theory, the only theory of uncertainty which has *this important property:*

> the likelihood of any event following the presentation of a sequence of points of data does not depend upon the order in which those data are presented.

➢ *Probability is a state of mind, not things.*

The Bayesian approach allows us to assign probabilities in once-off situations.

What is the value to you of a single toss of a coin: \$100 if heads, nothing if tails?

Define the *expected return* from the single toss to be the average return of a hypothetical series of many tosses: $\$100 \times ½ + \$0 \times ½ = \$50$. Treat unique events as if they were played over many times.

➢ All *prior experience* must be used in assessing probabilities. (Coins are almost always fair; it's warm enough to go to the beach most weekends in March in Sydney.)

➢ Decision making requires the assessment of *values* as well as probabilities.

Would you pay as much as \$50 to play in the once-off coin toss? Few people would; most people would pay a premium to reduce their risk: they are *risk averse*, and would sell their lottery ticket at something less than \$50; the lowest selling price is their *certain equivalent* (C.E.).

The *risk premium* equals the expected return less the certain equivalent, when selling.

Risk aversion can be defined and measured using *utility theory*.

- Decisions can only be made when a criterion is established for choosing among alternatives.

  The utility of a lottery is its expected utility.

  (by the definition of utility)

- The implications of the present for the future must be considered. What *discount rate* to use.

- Must distinguish between a *good decision* and a *good outcome*.

  Prudent decision-making doesn't guarantee the desired outcome invariably, but should improve the odds.

- Often we can, at a cost, reduce our uncertainty about Nature's future events (using market research, forecasting, statistical analysis). There must be a limit to what we should spend in these endeavours—how much is it?

  The value of perfect information. (VPI)

- The value of *im*perfect information is less.

  Often we can, at a cost, buy more certainty about the future (pay an insurance premium, buy a hedge against future outcomes).

  What is a fair price to pay?

2.6 Summary of Introduction

We need a methodology to help us make difficult decisions. Decision analysis provides that methodology.

Decision analysis focuses on what we don’t know, rather than on refining what we do know.

The best you can do is to integrate in a logical manner:

- ➢ What you can do.
- ➢ What you know.
- ➢ What you value.

Decision analysis has three distinct stages — *Structuring*, *Evaluation*, and *Agreement*.

The Simplest Decision

The simplest decision under uncertainty — calling a coin toss: you win $5 or nothing.

Highlights some concepts which are useful in more complex decisions.

Let's start with a volunteer (   ) and ask some questions.

1. Would you pay $1 for a ticket to play the game?
2. What's the minimum you'd sell the ticket for?
3. What's the maximum you'd pay for perfect information about the toss (from a clairvoyant)?
4. And for imperfect information?

Everyone write down your answers to Questions 2 and 3.

______ values this game at ___¢.

______ values *perfect information* at $_____

______ values *imperfect information* at < $_____

Consistency Check

Minimum selling price
(The Certain Equivalent)
+
Value of Perfect Information
=
Maximum Payoff

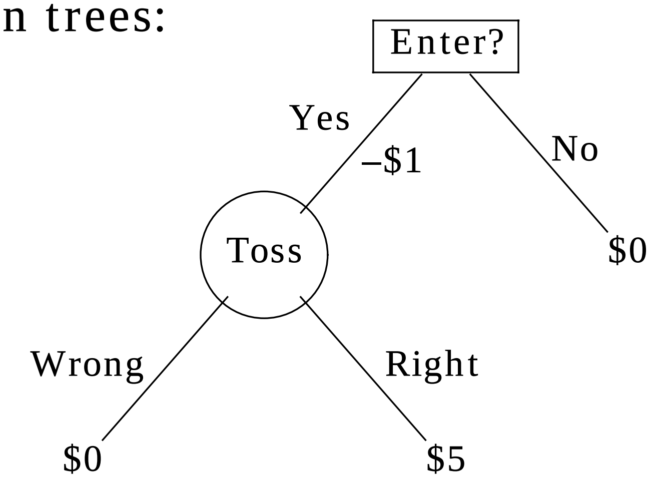
But why?

So the Value of Imperfect Information
must be less than
the Maximum Payoff
minus
Minimum selling price
(The Certain Equivalent)

Calling the Toss

Concepts:

- ➢ Uncertainty and probability
- ➢ Profit lotteries
- ➢ Decisions as allocations of resources
- ➢ Sunk cost — irretrievable allocations of resources
- ➢ Certainty equivalent — value of the lottery
- ➢ Information and probability
- ➢ Value of information
- ➢ Consistency in decision making
- ➢ Decisions versus outcomes
- ➢ What is meant by a *good decision*?
- ➢ Individual decisions, corporate decisions
- ➢ Decision trees:



2.6.1 Points to Ponder:

1. Probability is a state of mind (information)
2. Limit to the value of perfect information
3. Limit to the value of imperfect information
   < the value of perfect information
4. Consistency check:

   Certainty equivalent + VPI = maximum payoff.

5. ∴ Value of imperfect info. < max. payoff – C.E.

6. Risk averse or risk preferring or risk neutral?

2.7 Example 1: Coin Tossing

Coin tossing is one of the simplest decisions.

- on the fall of the tossed coin, Miriam stands to win \$50 or nothing.
- How much would you pay to play this game? Most people would pay no more than \$25—the expected or long-run return from the game—indeed most people would not even pay that. Most people are *risk averse*.
- It turns out that Miriam would pay no more than \$24 to play the game, (she would sell her ticket to play the game if offered at least \$24). Miriam, too, is risk averse: she's prepared to forgo \$1 in the expected, long-run payoff to avoid the uncertainty of the game.
- Her *risk premium* is \$1 in this game.
- Individuals more likely to be risk averse than firms, whose diverse and widely drawn ownership means they likely to be nearly *risk neutral*.

- Paying anything to play the game is a *sunk cost*, an irreversible allocation of scarce resources.
- If Miriam is offered *perfect information* about the toss? (what if Joe tosses the coin, catches it, and covers it without Miriam's seeing it? Then, after looking himself, could tell Miriam truthfully whether it's head or tails.)
- The game becomes a sure thing. Miriam would accept the information if free, correctly call the coin, and pocket the $50, (unless she was a rabid gambler).
- The maximum Miriam should pay for this perfect information? (It may seem that this is simply a function of Miriam's attitude to risk, which is true, but we have sufficient information about her preferences, to determine from her answer whether she's being *consistent*.)
- If she paid up to $26, she'd be being consistent, since she'd sell the lottery for $24 to end up with $24 for certain: paying $26 for perfect information gives the same outcome.
- If Joe told Miriam that he would lie with a probability of ⅓, how much would she pay for information, now imperfect? Less than $26.

This example contains three things which are found in much more complex decisions:

1. Consider the three elements of a decision identified here:

   - *actions* are her moves after she's made her decision, literally calling the toss: In this case the *actions* were what Miriam could call: "Heads" or "Tails".

   - *events* are Nature's possible moves, the state of the tossed coin: The *events* were the two possibilities: Heads or Tails.

   - *outcomes* are the returns after both players have moved—Miriam has called and the coin tossed—and the uncertainty is resolved: in this case either $50 for a correct call or nothing.

2. Miriam's *attitude to risk*, revealed when she announced the minimum she was prepared to sell the ticket for.

3. The *value of information*, limited by the value of perfect information, a function of the probabilities and payoffs, as we'll see below.

3. Decision Quality

3.1 Without Decision Quality …

- ➢ Garbage in — garbage out: GIGO
- ➢ Cannot maintain objectivity
- ➢ No better than intuition
- ➢ No commitment without quality
- ➢ No means to measure success

(See Matheson in the Readings.)

Strategic and operational decision making require different perspectives.

Operational Decision Making —

- ➢ Attends to details and follow through
- ➢ Concentrates on near-term performance
- ➢ Ignores uncertainty
- ➢ Is action based
- ➢ Is generally routine.

Strategic Decision Making —

- ➢ Focusses on important issues
- ➢ Considers long-term horizon
- ➢ Accounts for uncertainty
- ➢ Chooses among significantly different alternatives
- ➢ Generally once-off.

Organisations have difficulty achieving high-quality decisions routinely because of:

- ➢ Lack of creative and significantly different alternatives
- ➢ Too much time spent on unimportant details
- ➢ Competing values which are difficult to trade off
- ➢ Inappropriate scope of analysis
- ➢ Scope changes at each step in the approval process

Low-quality analyses often have these oversights:

- ➢ Implementation personnel are not included in the process
- ➢ The real decision maker is not involved
- ➢ Information is obviously biassed
- ➢ Analysis is a justification of a decision already made
- ➢ New issues are raised *after* recommendation

3.2 Six Dimensions of Good Decision Making.

① *The appropriate frame:*
the correct background, setting, and context

② *Creative, doable alternatives:*
no alternatives, no decision.

③ *Meaningful, reliable information*

④ *Clear values and trade-offs:*
criteria for measuring the value of and trading off alternatives

⑤ *Logically correct reasoning:*
which alternatives maximise value?

⑥ *Commitment to action:*
implementation.

3.2.1 Frame

① *The appropriate frame:*

the correct background, setting, and context

“Have we asked the right questions?”

“Are the assumptions clearly identified?”

“Have different areas of the organisation been heard from on this issue?”

“Does this course of action fit with the organisation’s strengths and larger objectives?”

3.2.2 Alternatives

② *Creative, doable alternatives:*

no alternatives, no decision.

“Have alternatives been identified and evaluated?”

“Is there a recovery plan in case of failure?”

“Is there a feasible plan for implementing the decision?”

3.2.3 Information

③ *Meaningful, reliable information*

"Have we asked the right questions and got valid answers?"

"What are the probabilities of technical and market success?"

"Have we obtained a cross-section of good information?"

"Have different areas of the organisation been heard from on this issue?"

3.2.4 Values

④ *Clear values and trade-offs:*

criteria for measuring the value of and trading off alternatives

"What is the risk/return relationship?"

"What is the expected value of the decision we're about to make?"

"What is the cost of failure?"

3.2.5 Reasoning

⑤ *Logically correct reasoning:*

which alternatives maximise value?

“Is there a clear logic to our approach to the decision?”

“What does our financial model tell us?”

“What does our marketing model tell us?”

“What does our technical model tell us?”

3.2.6 Commitment

⑥ *Commitment to action:*

implementation.

“Have different areas of the organisation been heard from on this issue?”

“Can the organisation get behind this decision?”

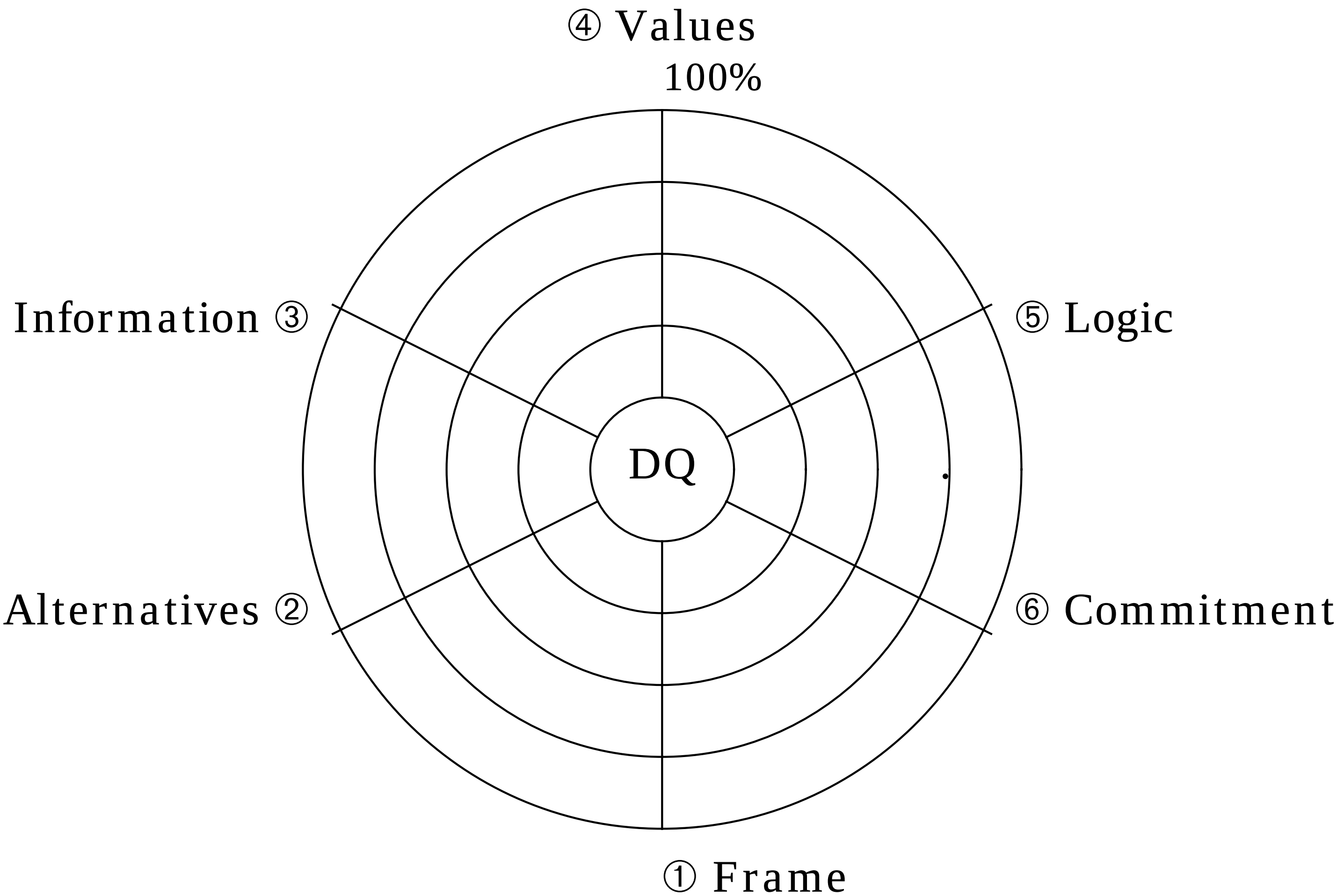
“Is there a feasible plan for implementing the decision?”

3.3 Measuring decision quality

Decision quality can be measured using a “spider” diagram.

Simple to use, and quickly points out which dimensions need attention.

Constructed by placing a dot on the axis of each dimension and then connecting the dots. The centre is zero percent quality, and the circumference is 100 percent, where additional effort to improve this dimension would not be worth the cost.


④ Values
100%
Information ③
⑤ Logic
DQ
Alternatives ②
⑥ Commitment
① Frame

Decision Quality Checklist.

➢ Management commitment to:

— the process and

— the recommendations

➢ Correctly framed problem

➢ Reliable, honest information

➢ Adequate time and resources

➢ Trained facilitators and analysts

➢ Thorough communication of the process and its results to the organisation.

3.4 Summary of Decision Quality

Without decision quality the analysis is no better than an intuitive process.

The Six Dimensions of Good Decision Making provide the foundation for ensuring decision quality.

A quality process must be in place so that the decision process is not coopted or perverted to provide predetermined answers.

The value of any analysis is the insight it provides, not the output.

e.g. golf: luck or technique?

4. Structuring the Decision

4.1 Define the Problem and the Decision Criterion

To begin structuring the decision, we must first define the problem and the decision criterion.

➢ What is the decision?

➢ Who is the decision maker?

➢ What is the decision criterion?

the decision criterion can be anything that allows the decisionmaker to quantitatively distinguish one alternative from another:

— Net present value (NPV)

— Internal rate of return (IRR)

— Cash flow

— Goodwill/reputation

— Others

Brainstorming

Once the problem has been defined, we need to brainstorm and sort issues.

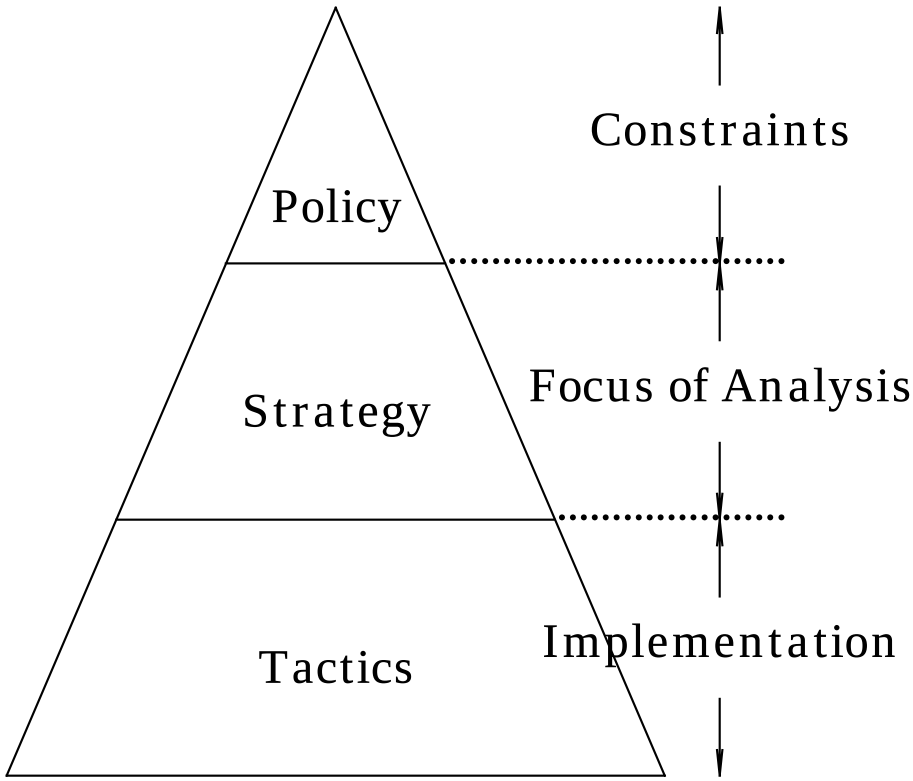
Raise issues.

Separate issues in order to begin problem framing.

Categorise the decisions using the decision hierarchy, to help identify the scope of the problem and to separate constraints and implementation from the focus of the analysis.

4.1.1 The Decision Hierarchy

The focus of decision analysis is at the strategic level.



Policy decisions are constraints.

Strategy decisions are the focus of the analysis.

Tactical decisions are follow-on implementation decisions.

4.2 Influence Diagrams

The next step is to model the decision making using influence diagrams.

Influence diagrams:

- ➢ Provide a clear, graphical picture of a problem
- ➢ Show relationships and relevance
- ➢ Facilitate dialogue among team members with different backgrounds and interests
- ➢ Provide a means to compare alternatives
- ➢ Cannot have circular references or feedback loops
- ➢ Are not flow diagrams

Uncertainties are chance events, ○

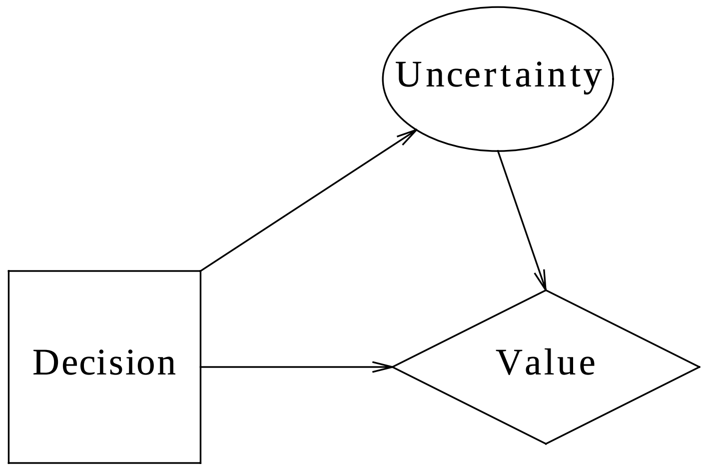
Decisions are controllable, □

Values are what you prefer, ◇

Arrows indicate relevance, →

Influence diagrams typically flow from decisions to uncertainties to value.

Arrows indicate relevance and show relationships.



Be careful when adding an arrow: *influence diagrams are not flow charts*. The lack of an arrow says more than having an arrow.

An arrow into an uncertain node ◯ means relevance.

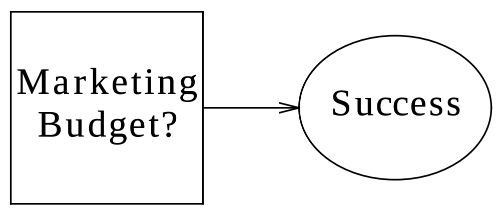
An arrow into a decision node □ means is “known”.

An arrow into a value node ◊ means “functional”.

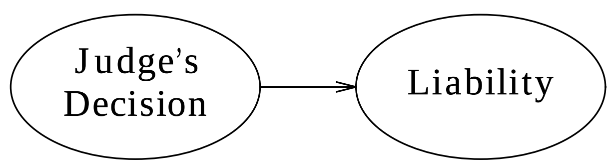
Three Types of Influence:

(See DATA 3.5 Manual.)

1. *Probabilistic Influence*

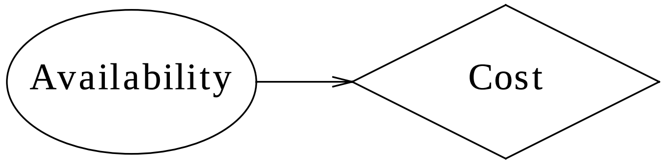


Decision about the Marketing Budget influences the probability of success.

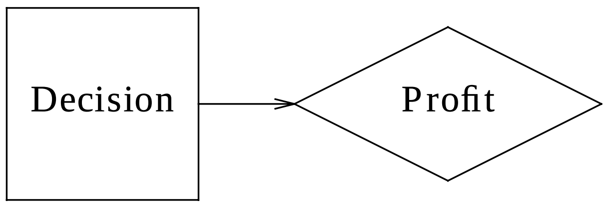


The probability of the defendent's liability depends on whether the judge will admit particular evidence.

2. *Value Influence*

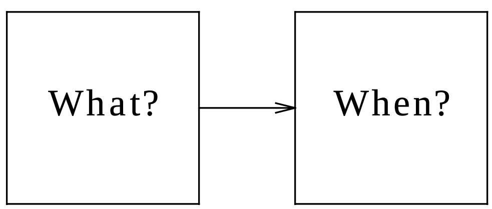


The manufacturing cost depends on the (unknown) local availability of an input.



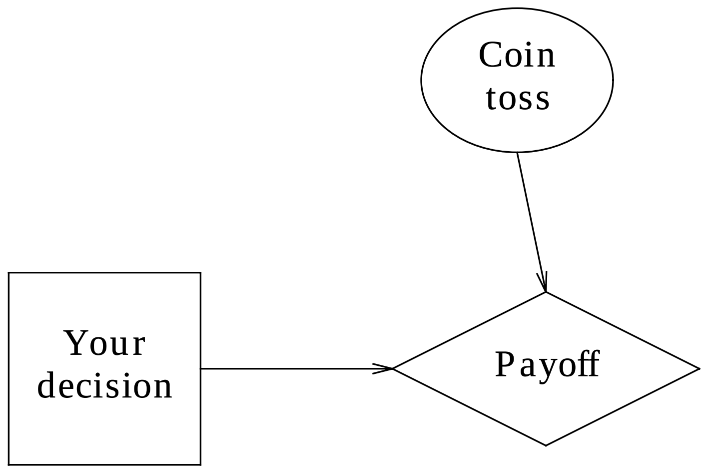
The manager's decisions influence the profit of a plant.

3. *Structural Influence*



What to make is decided before When to make it.

The influence diagram for the coin-tossing decision:



Since your decision (of whether to invest, and, if so, whether to call “heads” or “tails”) does not influence the outcome of the coin toss, there is no arrow from the decision node to the chance node.

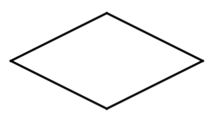
And since you will call the toss before you know the outcome, the arrow from the chance node goes to the payoff node.

This is a very common Influence Diagram. Other examples?

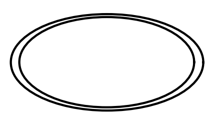
4.2.1 Influence Diagrams — Summary

An influence diagram provides a simple graphical representation of a decision problem. It contains at least three elements, linked with arrows to show the specific relationships among them:

- *Decisions* are represented by squares □ or rectangles.
- *Chance events* (the uncertainty of which will be resolved before the payoff) are represented by circles ○ or ellipses.
- *Values* or payoffs are represented by diamonds:



- *Deterministic nodes* are represented by double ellipses::



Influence diagrams provide a snapshot of the decision environment at one point in time.

They are not flow charts or diagrams.

They cannot contain cycles.

The arrows must indicate how uncertainty is revealed (all will be revealed before the final payoff, but decisions are made with some uncertainty remaining).

4.3 The Glix Case:

The Gaggle Company has developed a new product — Glix. While you think that Glix has great potential, you are unsure whether Glix will be profitable if brought to market.

Issues about Glix include:

- ➢ Whether to:
  - — launch Glix
  - — sell Glix to another company
  - — license Glix
- ➢ Market size
- ➢ Revenue
- ➢ Marketing costs
- ➢ Profit
- ➢ Share price
- ➢ Manufacturing costs
- ➢ Regulations

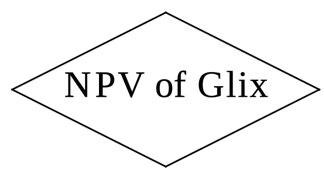
Begin by clarifying the decision and the decision criterion, and work from right to left.

The *decision* is whether

- ➢ to launch,
- ➢ to sell, or
- ➢ to license

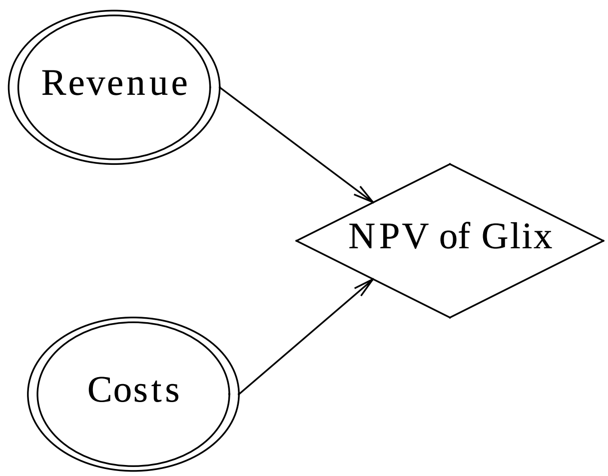
the Glix product.

Management have determined that net present value (NPV) is the correct decision *criterion*.



Launching Glix: What are the determinants of net present value?

- Revenue
- Cost

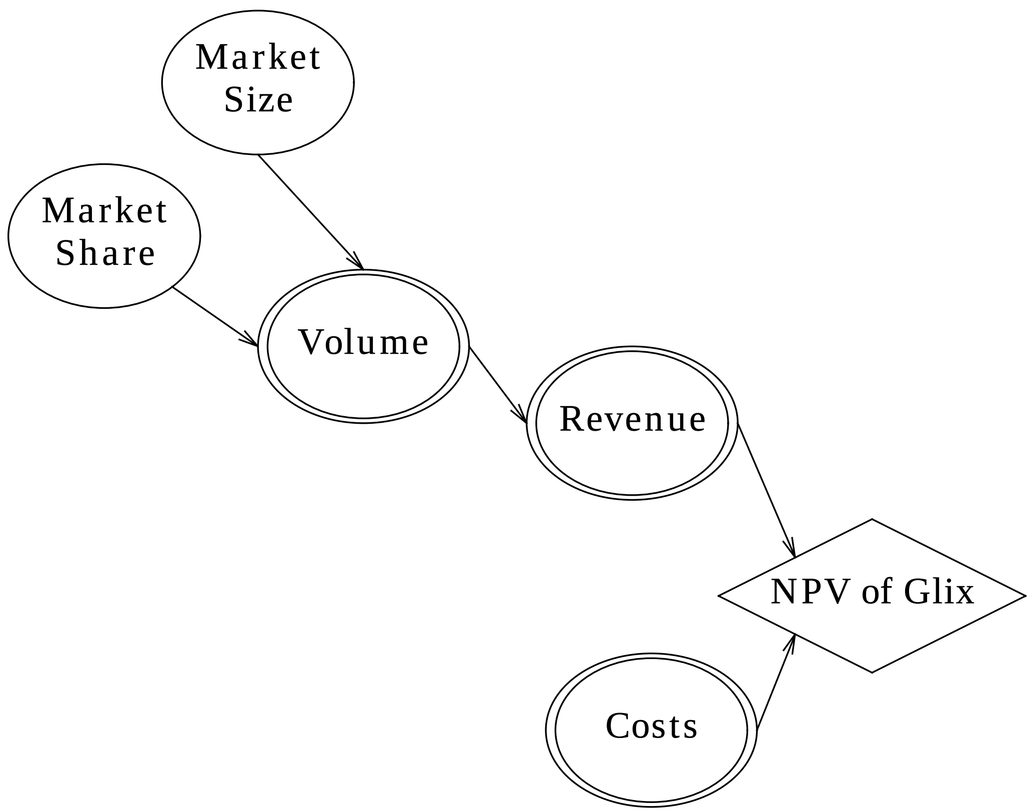


The double circles/ellipses are *deterministic nodes*: given the inputs from the predecessor (upstream) nodes, the outcome of the deterministic node can be found immediately.

What are the determinants of revenue?

What do you need to know the calculate revenue?

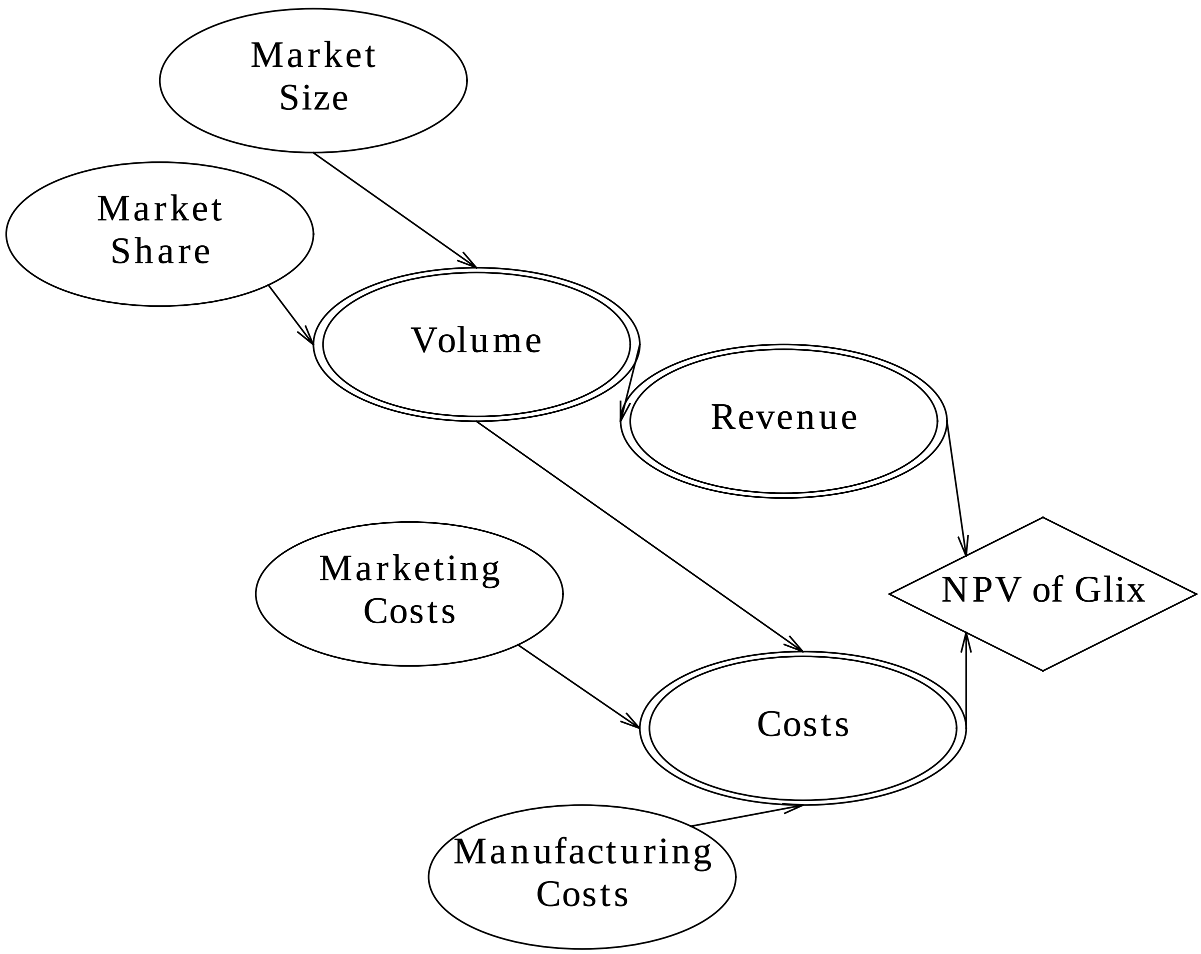
Consider the price of Glix to be $5.00 per kilo.



Next consider the determinants of cost.

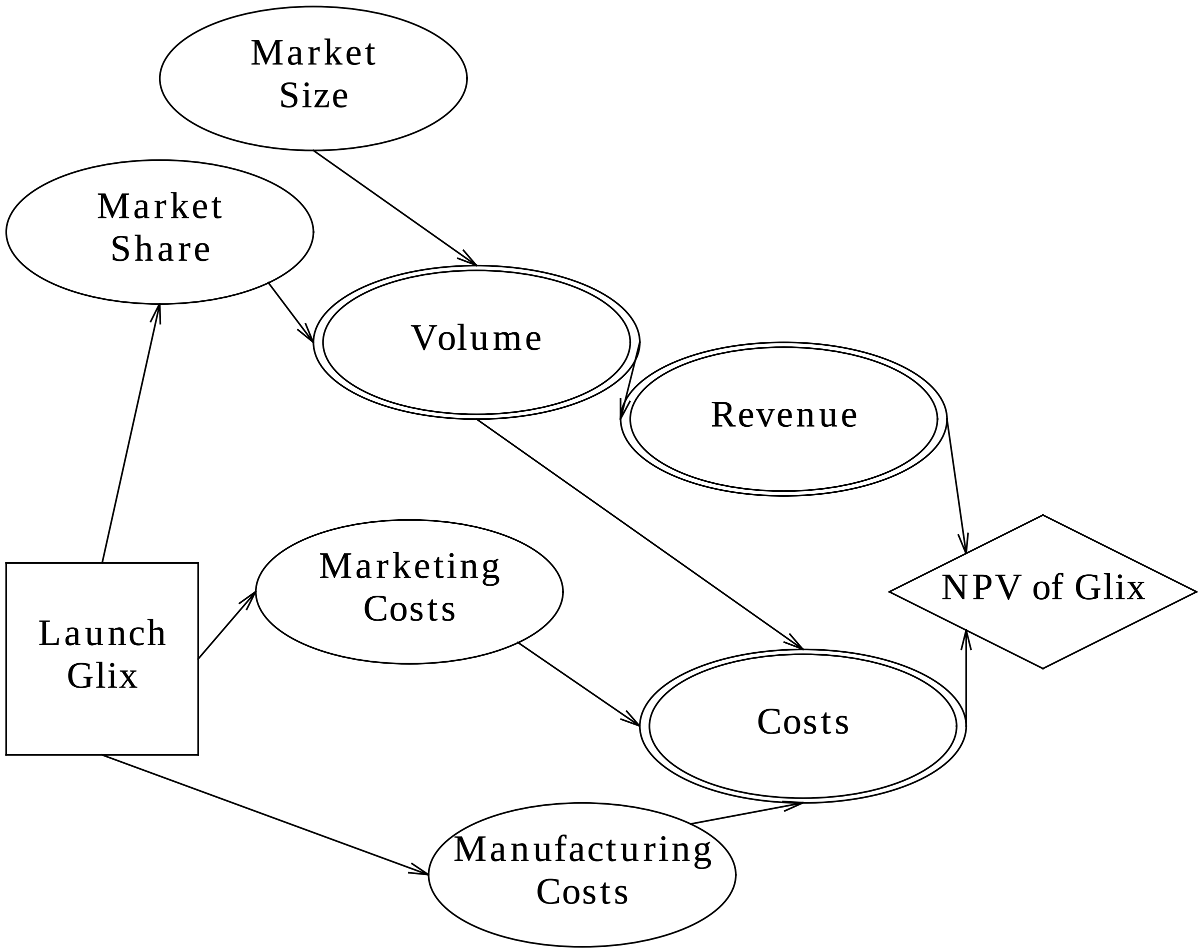
What do you need to know to estimate the costs associated with Glix?

There is a factory in place that will only need minor modifications at a cost of $1,500,000.



Lastly, we need to add the decision.

Which key uncertainties does the decision influence?



4.4 Decision Trees

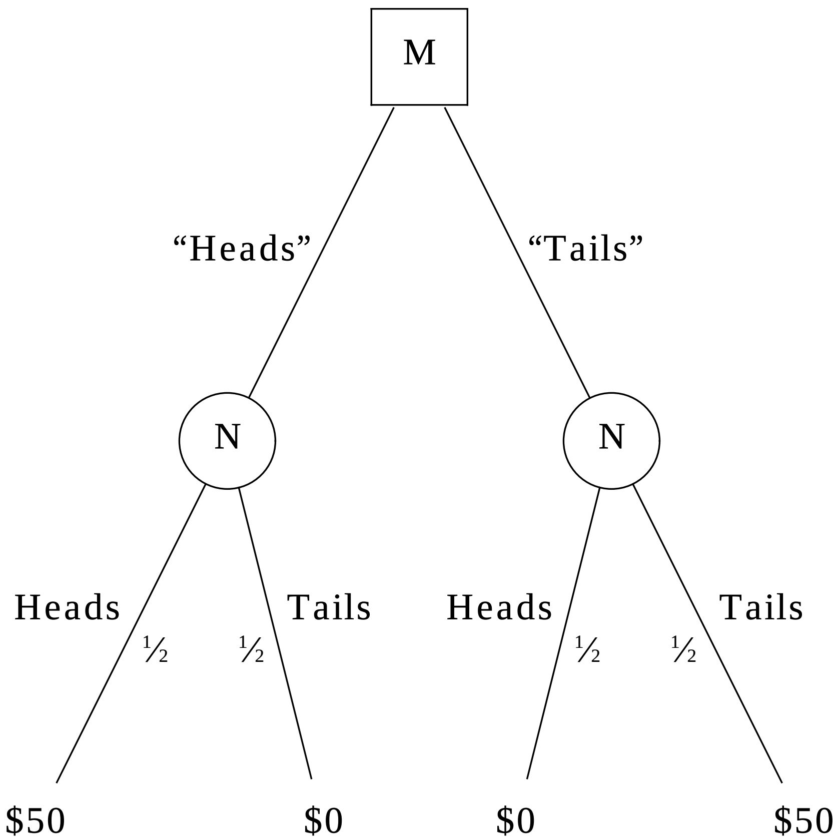
A decision tree is a flow diagram that shows the logical structure of a decision problem. It is a visual aid to lay out all the elements of a decision. It contains four elements:

- *Decision nodes,* □, which indicate all possible courses of action open to the decision maker;
- *Chance nodes*, ◯, which show the intervening uncertain events and all their possible outcomes; i.e., Nature plays
- *Probabilities* for each possible outcome of a chance event; and
- *Payoffs,* which summarize the consequences of each possible combination of choice and chance.

Decision analysis forces you to think carefully about:

- the true nature of the decision problem;
- the role of chance; and
- the nature of the sequential interaction of decisions and chance events.

Miriam's decision tree looks like this:



Coin Tossing

- In Miriam's coin-tossing game the *probabilities* were easy to work out—after all, we've all tossed coins.
- in many decisions, you may have to derive the probabilities by prior experiment, where possible, or by simply making a best estimate based on any prior experience
- *Imperfect information* is not as valuable as perfect information.

Example: *weather forecasts*

- The value of weather forecasts varies from company to company and from person to person.
- depends upon the company’s or person’s abilities to take actions in response to forecasts to reduce losses or to increase profits.
- e.g., a local department store will have to decide when to phase out their summer fashion range and highlight the winter range.
- Sometimes choosing when to act is done by custom or convention, sometimes by watching rival stores.
- But it can also be decided using decision analysis.

Q: If accurate weather forecasts were available for a price, what should the store pay for them?

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

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
- the levels of future interest rates
- the levels of future exchange rates

None of these is a simple “High” versus “Low” type: you can’t simply say that the future demand for a product, say, will be High or Low.

Rather than trying to identify all possible levels, you can determine thresholds, or points at which the prudent decision changes from one action to another, using *sensitivity analysis*.

Moral: There are no payoffs for spending more time and money to obtain more information than you really need.

4.5 Case 3: Laura's Shoe Decision

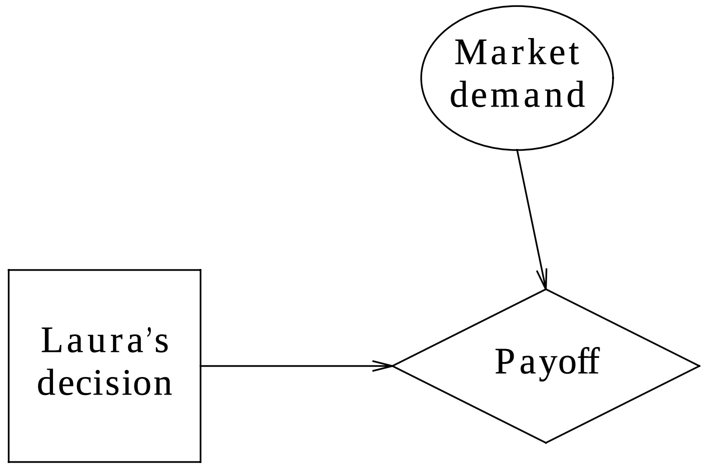
The Decision Maker: Laura, a divisional manager of a large department store,

Her decision: must decide on the new season's range of styles of footwear.

She has a choice of *actions:*

- ➢ the "Trad" range, not risky, could cater to a traditional segment of the market
  For the budgeted investment in this range, a net return of $200,000.
- ➢ the "Retro" range, risky, a new range of 1940s retro shoes.
  - — if it's a goer (successful), the net return will be $240,000, but
  - — if it's a fizzer (failure), she'll net only $150,000.
  - — 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:



Very similar to the influence diagram of the die-rolling decision.

Since Laura's decision of which fashion line to go with does not influence the market outcome (whether or not Retro will be a success), there is no arrow from the decision node to the chance node.

And since Laura will choose the line before she knows how the market will respond to it, the arrow from the chance node goes to the payoff node.

Advertising?

Pricing?

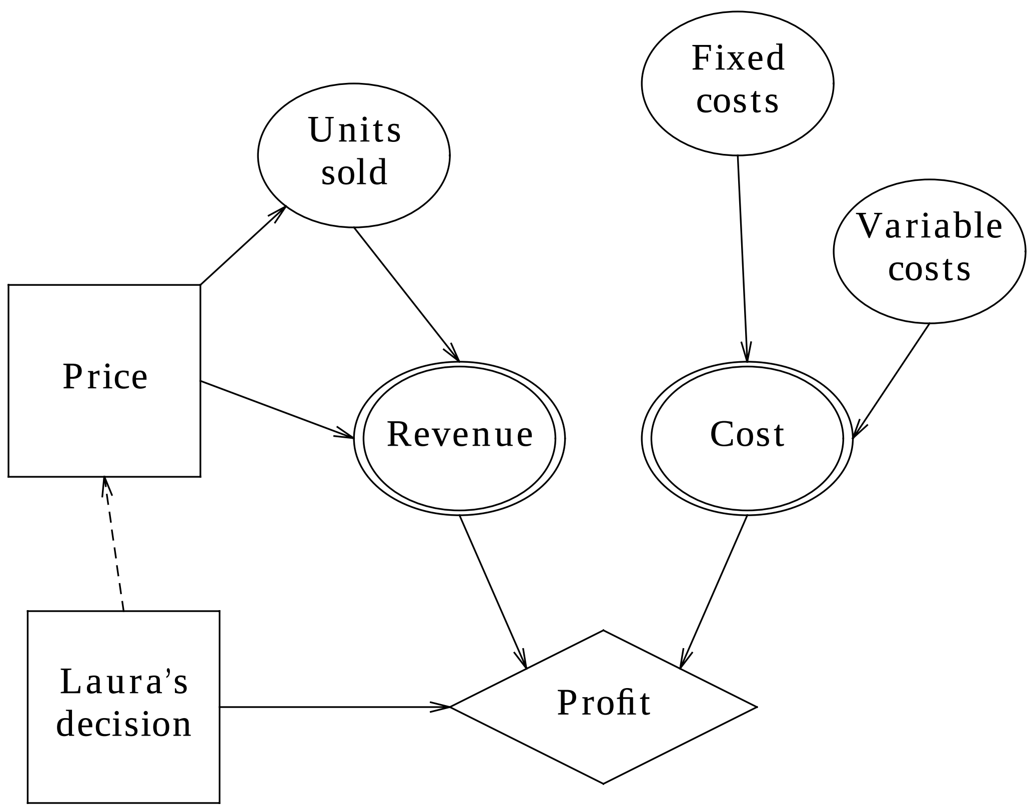
Promotion?

Possible to consider the decision in more detail:

— what prices to charge for the new line;

— how this affects the numbers sold and so the revenues;

— how the uncertainty over the fixed costs of setting up the new range and the uncertainty of the costs of production and promotion will impact on the profit.

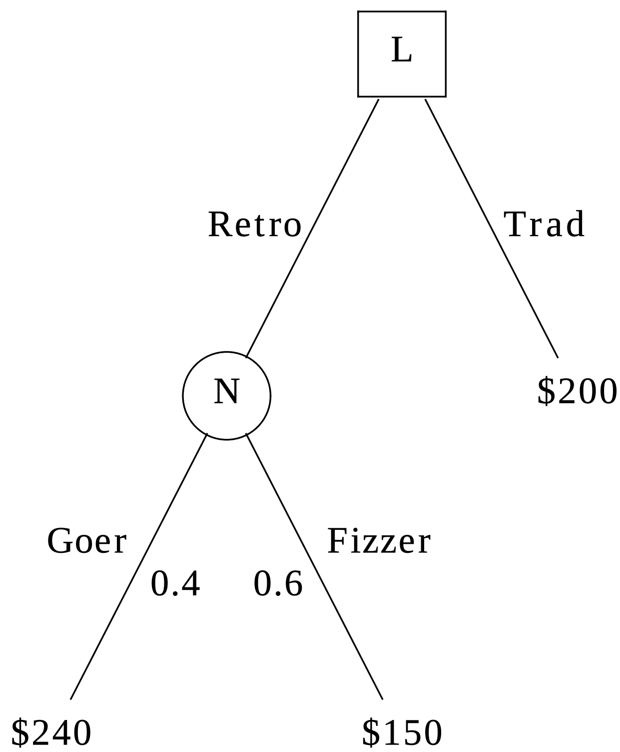


The double circles/ellipses are *deterministic nodes*: given the inputs from the predecessor (upstream) nodes, the outcome of the deterministic node can be found immediately.

After the conditioning variables of the decisions and the chance events are known, there is no uncertainty.

Deterministic nodes are useful in simplifying an influence diagram.

The *decision tree* for Laura's decision:



With the payoffs and probabilities, Laura can calculate:

- ➢ the long-run, expected return of Retro, the payoffs weighted by the probabilities:
  $\$240{,}000 \times 0.4 + \$150{,}000 \times 0.6 = \$186{,}000.$
- ➢ which is less than the certain return of \$200,000 for Trad.

A risk-neutral or risk-averse decision maker would opt for Trad.

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.

Checklist for structuring:

➢ Have the objectives for this project been defined and agreed to?

➢ Has the scope of this project been defined appropriately?

➢ Who is the sponsor of the project?

➢ What is the decision criterion?

➢ Have appropriate resources been committed?

4.6 Summary of Structuring

Influence diagrams provide a graphical description of the essence of the problem.

Software (such as Treeage's DATA) allows us to model the entire decision as an influence diagram, which can be transformed into a decision tree and solved.

Influence diagrams are also a good communication tool.

The focus of decision analysis should be at the strategic level.

Brainstorming issues and then separating the issues into decisions, uncertainties, objectives, and facts helps to frame the problem.

4.7 Why Use An Influence Diagram?

IDs provide the ability to:

— capture and

— communicate

the essence of a problem in an easy-to-understand manner. In doing so they:

➢ Help to structure the problem discussion,

➢ Identify influences and dependencies between decisions and uncertainties,

➢ Show how the value is created,

➢ Provide a means to identify information sources and to assign tasks,

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

4.8 Step-By-Step Procedure

IDs as much an art as a science. Focus on developing a clear and meaningful diagram. Ask probing questions. Make sure *not* to develop a flow diagram. IDs do not have feedback loops.

Step 1: Explain to the team why this is important and how it will be used.

Step 2: Consider the essence of the problem: is it business, marketing, R&D, exploration etc?
Helps to guide the development of the diagram.

Step 3: Put a value node labelled with the decision criterion at the middle of the RHS of the page.
Most diagrams use NPV as the value node, influenced by Revenue and Costs.

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

Step 5: Choose one uncertainty influencing the value node, and develop it completely before tackling the other nodes. Make sure the nodes are clearly defined and specific.

Step 6: Review the uncertainties on the previous issue-raising list: should those missing from the diagram be included? If not, why not?

Step 7: Identify deterministic uncertainty nodes, designated by double ovals. Can you write the formulas for the value in these nodes? If not, list the missing information.

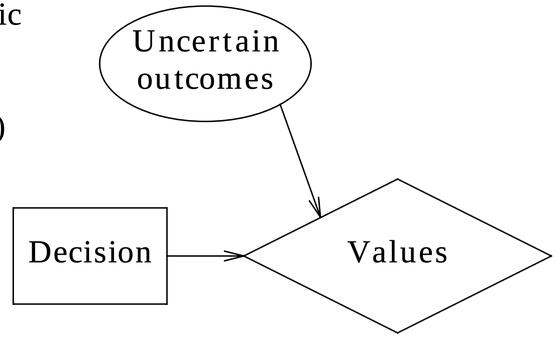
Step 8: Identify information sources and write each source’s name by the node it can resolve.

Step 9: Is the diagram complete and has the problem been described accurately?

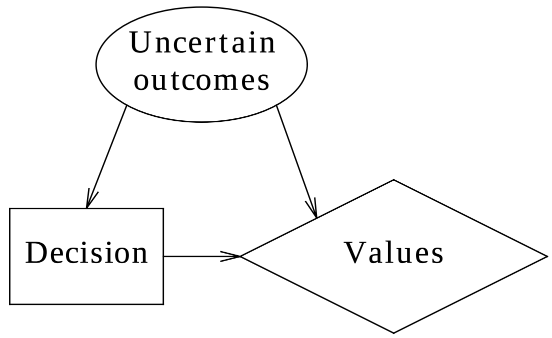
Step 10: Write an information-gathering task list.

4.9 Types of Influence Diagrams

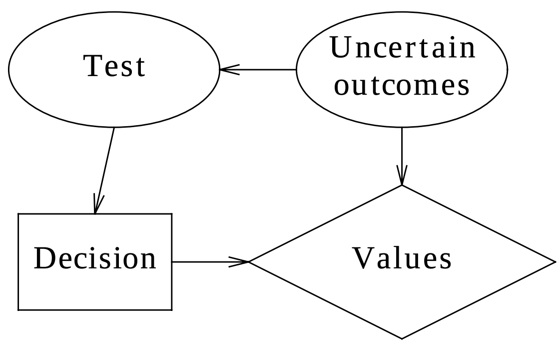
1. Simple, 1-stage, non-strategic decision, then resolution of uncertainty, then payoffs. (Laura's marketing decision)



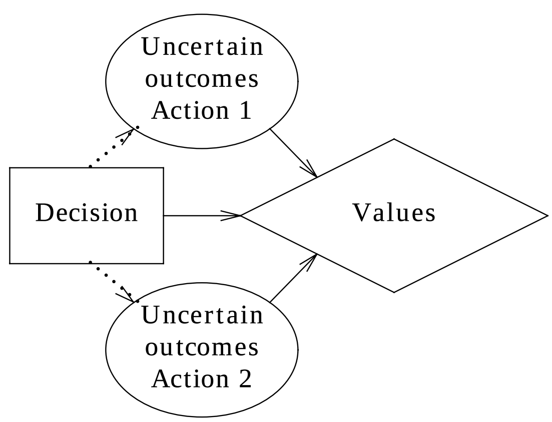
2. As no. 1, plus Value of Perfect Information. (Compare EV of 2. with the EV of 1.) (e.g. the clairyoyant)



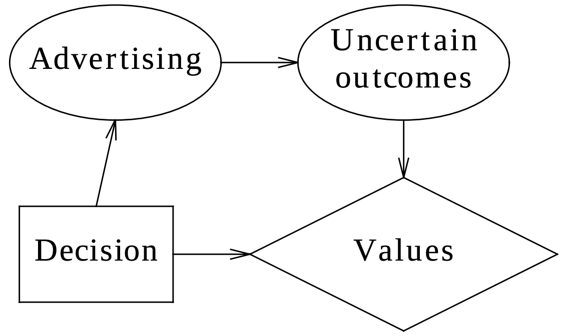
3. Value of Imperfect Information (Compare the EV of 3. — less than the EV of 2. — with the EV of 1. (e.g. test marketing, forecasting)



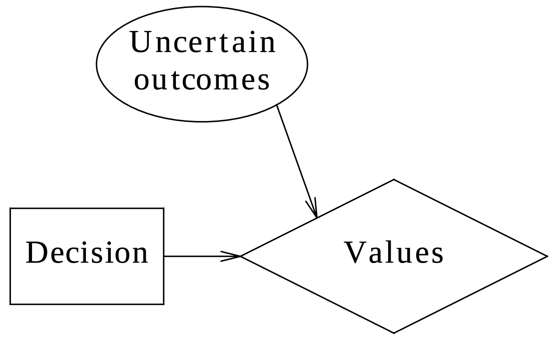
4. Probabilities are a function of the alternative chosen. (e.g. nuptial vows)



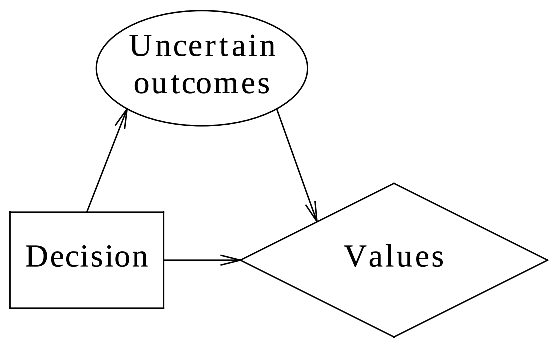
5. Decision influences the probabilities.
(e.g. advertising)



6. Insurance
(such as an umbrella)



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



8. Two-stage decision
(e.g. Pennzoil)