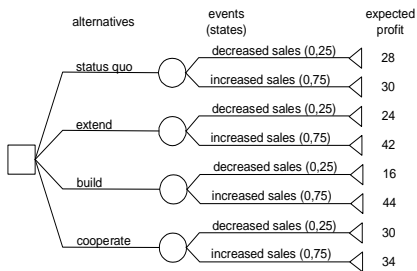


Decision Analysis Part 3: Influence Diagrams

Marko Boharac

Working Example

Decision tree:



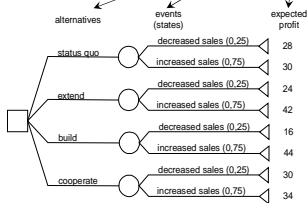
Marko Boharac

Motivation for Influence Diagrams

Decision trees:

- sometimes too detailed,
- grow exponentially,
- contain repeated information.

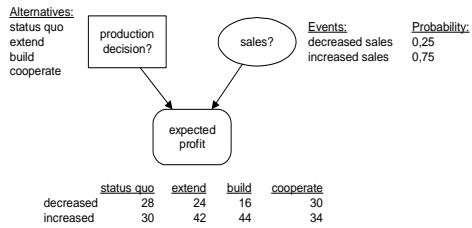
Only three different elements:



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Working Example

Equivalent *Influence diagram*:



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Influence Diagram

Influence diagram is a:

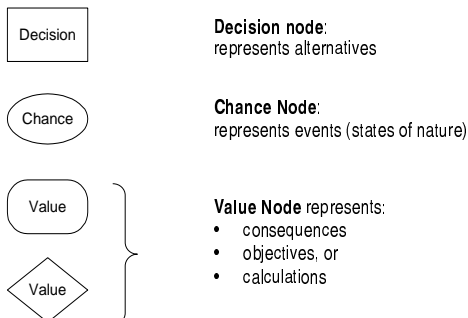
- high-level (compact),
- visual representation,
- displaying relationships between essential elements that affect the decision.

Two levels of detail:

- higher: only elements and relations
- lower: detailed information defined with each element

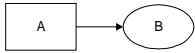
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Elements of Influence Diagrams

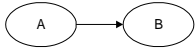


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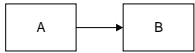
Arcs in Influence Diagrams



Decision A affects the probabilities of event B;
Decision A is relevant for event B



The outcome of event A affects the probabilities of event B;
Event A is relevant for event B



Decision A occurs before decision B;
Decisions A and B are sequential



Decision B occurs after event A;
The outcome of A is known when deciding about B

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Developing Influence Diagrams

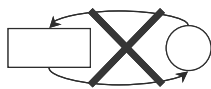
Two basic strategies:

- Start with outcomes and model towards decisions and events
- Gradually add more and more detail

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Common Mistakes

1. An influence diagram is not a flowchart.
2. An arc from a chance node into a decision node means that the decision-maker knows the outcome of the chance node when making the decision.
3. There can be no cycles:



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Decision Trees : Influence Diagrams

- DT display more information, the details of a problem, but they may become “messy”.
- ID show a general structure of a problem and hide details.
- ID are particularly valuable for the structuring phase of problem solving and for representing large problems.
- Solving algorithms: DT straightforward, ID difficult
- Any properly built ID can be converted into a DT, and vice versa.

- Bayesian networks are ID's containing only event nodes

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Solving Influence Diagrams

- A. Convert ID to DT, solve DT
or
B. Solve directly by node reduction:
1. Cleanup: one consequence C , no cycles, transform calculation nodes to one-event chance nodes...
 2. Repeat until ID solved:
 1. Reduce (calculate EV of) all chance nodes that directly precede C and do not precede any other node.
 2. Reduce (calculate EV of) the decision node that directly precedes C and has as predecessors all of the other direct predecessors of C .
- + arc reversal where there are no nodes corresponding to 2.2

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Influence Diagram Software

Add-Ins for Microsoft Excel:

- PrecisionTree: <http://www.palisade-europe.com/precisiontree/>

Influence-Diagram Development Programs:

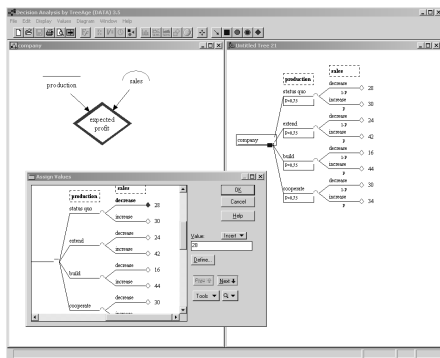
- GeNIe: <http://genie.sis.pitt.edu/>
- TreeAge Pro (DATA): <http://www.treeage.com/>
- DPL: <http://www.syncopationsoftware.com/>
- Analytica: <http://www.lumina.com/ana/whatisanalytica.htm>
- HUGIN: <http://www.hugin.com/>
- Netica: <http://www.norsys.com/>

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Exercises

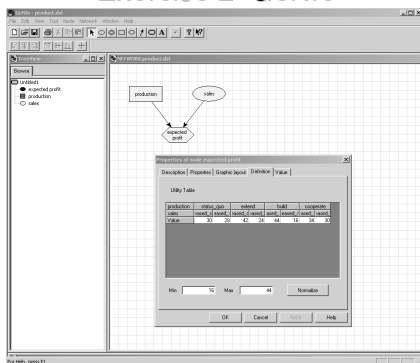
Markus Böhm

Exercise 1: DATA



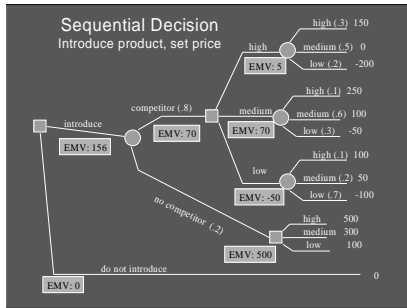
Markus Böhm

Exercise 2: GeNIe



Markus Böhm

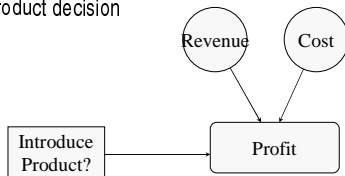
Exercise 3: Develop ID



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Example 1: Gradual Development (1/3)

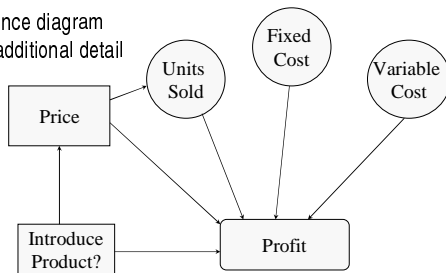
Influence diagram of a new product decision



Marko Boharac

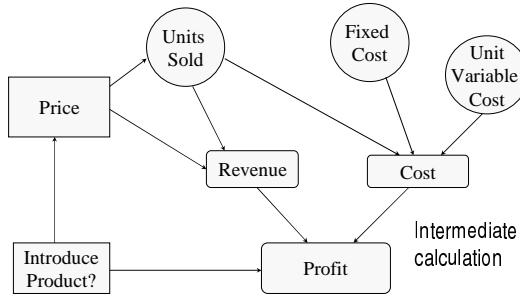
Example 1: Gradual Development (2/3)

Influence diagram with additional detail



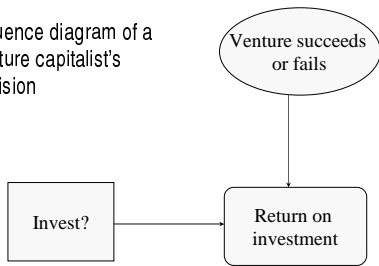
Marko Boharac

Example 1: Gradual Development (3/3)

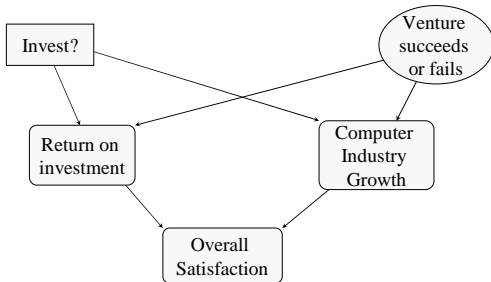


Example 2: Multiple Objectives (1/2)

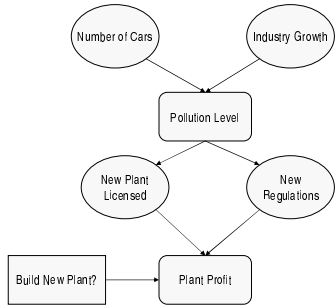
Influence diagram of a venture capitalist's decision



Example 2: Multiple Objectives (2/2)

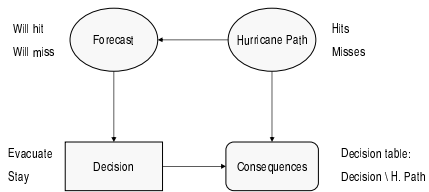


Example 3: Intermediate Calculations



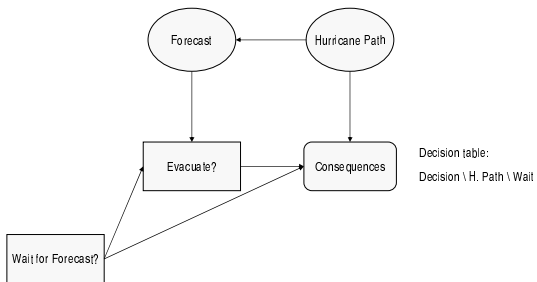
Marko Boharac

Example 4: Evacuation Decision (1/2)



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Example 4: Evacuation Decision (2/2)



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Exercise 4

Create influence diagrams representing the decision trees encountered so far:

1. Oilco
2. Take an umbrella
3. Service station

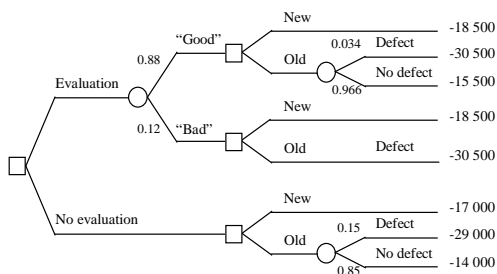
Markus Bohner

Exercise 5: Tractor Buying (1/3)

- Your uncle is going to buy a tractor. He has two alternatives:
 1. A new tractor (17 000 €)
 2. An used tractor (14 000 €)
- The engine of the old tractor may be defect, which is hard to ascertain. Your uncle estimates a 15 % probability for the defect.
- If the engine is defect, he has to buy a new tractor and gets 2000 € for the old one.
- Before buying, your uncle can take the old tractor to a garage for an evaluation, which costs 1 500 €.
 - If the engine is OK, the garage can confirm it without exception.
 - If the engine is defect, there is a 20 % chance that the garage does not notice it.

Markus Bohner

Exercise 5: Tractor Buying (2/3)



Markus Bohner

Exercise 5: Tractor Buying (3/3)

Do the following:

1. Solve the decision tree
2. Develop equivalent influence diagram:
 1. structure of nodes
 2. detailed node data (names, values, probabilities)

Markus Böhm
