Decision Making

BUS 735: Business Decision Making and Research

Goals and Agenda

Learning Objective	Active Learning Activity
Learn how to make decisions with uncertainty, without using probabilities.	Lecture / Example problems.
Practice what we learn.	In-class exercise.
Learn how to make decisions with uncertainty, using probabilities.	Lecture / Example problems.
Practice what we learn.	In-class exercise.
More practice.	Read Chapter 12, Homework exercises.
Assess what we have learned	Quiz

Decision Making Without Probabilities
Decision Making With Probabilities

Maximax Decision
Maximin Decision
Minimax Regret Decision
Maximum-Weighted Decisions

Decision Making Without Probabilities 3/ 19

- Suppose you have to decide on one of three choices for your business:
  1. Expand facilities.
  2. Renovate existing facilities.
  3. Do nothing.
- Each have costs (known) and benefits (unknown).
- Suppose profits depend on economic conditions:

Decision	Good Economic Conditions	Bad Economic Conditions
Expand	$150,000	-$10,000
Renovate	$90,000	$10,000
Do nothing	$70,000	$40,000

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Maximax Decision   4/ 19

- Problem: probabilities of having good economic conditions or bad economic conditions are unknown.
- Maximax Decision:

    - Compute the best (maximum) outcome for each choice (very optimistic).

    - Choose the maximum of the best outcomes.

    - Choosing options given best-case scenarios.

Decision	Good Economic Conditions	Bad Economic Conditions	Maximum
Expand	$150,000	-$10,000	$150,000
Renovate	$90,000	$10,000	$90,000
Do nothing	$70,000	$40,000	$70,000

- Maximum of maximums = $150,000. Choice = Expand!

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Decision	Good Economic Conditions	Bad Economic Conditions	Minimum
Expand	$150,000	-$10,000	-$10,000
Renovate	$90,000	$10,000	$10,000
Do nothing	$70,000	$40,000	$40,000

- Maximum of minimums = $40,000. Choice = Do Nothing!

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Minimax Regret Decision   6/ 19

- **Regret** is the difference between the payoff of a given decision and the best decision under a given scenario.
- Example: Suppose you chose to *do nothing* and there ended up being good economic conditions.

    - Best decision given good economic condition is to *expand*. Profit = $150,000.
    - Profit from *doing nothing* given good economic condition is $70,000.
    - Regret = $150,000 - $70,000 = $80,000.

- Minimax Regret Decision:

    - Compute regrets for every cell in table..
    - Find the maximum regret for each decision.
    - Choose the minimum of these maximum regret values.

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- Payouts Table:

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- Regrets Table:

Decision	Good Economic Conditions	Bad Economic Conditions	Maximum
Expand	$0	$50,000	$50,000
Renovate	$60,000	$30,000	$60,000
Do nothing	$80,000	$0	$80,000

- Minimum of maximum regrets = $50,000. Choice = Expand!

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Equally Likely Decision

- Suppose (for no reason whatsoever) that each outcome is equally likely.
- Compute weighted average of each decision (with equal weights).
- P(Good Economic Conditions) = P(Bad Economic Conditions) = 0.5.
- Equal Likelihood Table:

Decision	Good Economic Conditions	Bad Economic Conditions	"Expected" Value
Expand	$150,00	–$10,000	$70,000
Renovate	$90,000	$10,000	$50,000
Do nothing	$70,000	$40,000	$55,000

- Maximum "expected" value = $70,000. Decision = Expand!

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Hurwicz Decision

- Take a weighted average again, but choose an arbitrary weight for the best-case value.
- Coefficient of optimism, given by α, is a measure of the decision makers optimism.
- Best-case weight $= \alpha$, worst-case weight $= (1 - \alpha)$.
- Suppose $\alpha = 0.2$ (very arbitrary).

Decision	Good Economic Conditions	Bad Economic Conditions	"Expected" Value
Expand	$150,00	-$10,000	$22,000
Renovate	$90,000	$10,000	$26,000
Do nothing	$70,000	$40,000	$46,000

- Maximum "expected" value $= \$46,000$. Decision $=$ Do Nothing!

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- Take a weighted average again, but choose an arbitrary weight for the best-case value.
- Coefficient of optimism, given by α, is a measure of the decision makers optimism.
- Best-case weight $= \alpha$, worst-case weight $= (1 - \alpha)$.
- Suppose $\alpha = 0.2$ (very arbitrary).

Decision	Good Economic Conditions	Bad Economic Conditions	"Expected" Value
Expand	$150,00	-$10,000	$22,000
Renovate	$90,000	$10,000	$26,000
Do nothing	$70,000	$40,000	$46,000

- Maximum "expected" value $= \$46,000$. Decision $=$ Do Nothing!

Decision Making Without Probabilities
Decision Making With Probabilities

Maximax Decision
Maximin Decision
Minimax Regret Decision
Maximum-Weighted Decisions

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Dependence on Optimism

- Coefficient of optimism can be very difficult to choose.
- Optimal choice might vary a lot depending on this parameter.
- For each pair of decisions, find the cut-off value of α that leads one to switch decisions.

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Summary of Results

Criterion	Decision
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Equal Likelihood	Expand
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- **Dominant decision:** when same choice is made for every criterion considered.
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- **Dominated decision:** when choice is never made for every criterion considered.

- Suppose probabilities for good economic conditions and bad economic conditions are known.
- Suppose P(Good Economic Conditions) 0.6, P(Bad Economic Conditions) = 0.4.

Decision	Good Economic Conditions	Bad Economic Conditions	Expected Value
Expand	$150,00	-$10,000	$86,000
Renovate	$90,000	$10,000	$58,000
Do nothing	$70,000	$40,000	$58,000

- Maximum expected value = $86,000. Decision = Expand!
- A **risk neutral** decision maker should make this decision.

Expected Values: Probabilities Known

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Expected Opportunity Loss

- **Expected opportunity loss (EOL)** $=$ expected value of regret for each decision.

- Regrets Table:

Decision	Good Economic Conditions	Bad Economic Conditions	Expected Value
Expand	$0	$50,000	$20,000
Renovate	$60,000	$30,000	$48,000
Do nothing	$80,000	$0	$48,000

- Minimum expected regret $=$ $20,000. Decision $=$ Expand!

- Minimum expected loss decision *will always be equal to* maximum expected value decision.

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Expected Value of Perfect Information

- Suppose you could purchase "perfect information" about what will happen. How much would you pay?
- If you were told good economic conditions:
    - Decision = Expand, Profit = $150,000.
- If you were told bad economic conditions:
    - Decision = Do nothing, Profit = $40,000.
- A priori expected profit (given you will make a perfect decision):
    - Expected Profit = (0.6)($150,000) + (0.4)($40,000) = $106,000.
- Expected profit from maximizing expected value = $86,000.
- EVPI = $106,000 - $86,000 = $20,000.
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Bayesian Analysis

- **Bayesian analysis:** decision making using additional information which alter conditional probabilities.
- Suppose P(good economic conditions), P(bad economic conditions) are simply based on past history.
- Suppose your the Minneapolis Federal Reserve Bank issues an economic report (which they do) that indicates whether they have a positive economic outlook or a negative economic outlook.
- This is useful information, but not *perfect information*.
- Define the following events:

    - P: positive economic report.
    - N: negative economic report.
    - g: Good economic conditions.
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- Of course, $P(P) = 1 - P(N)$, $P(g) = 1 - P(b)$.

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Decision Making With Probabilities

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Bayesian Analysis

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Bayesian Analysis

- Suppose generally, good economic conditions occur 60% of the time, and bad economic conditions occur 40% of the time.
- Suppose past experience indicates the Federal Reserve report accurately forecasts...
  - good economic conditions 80% of the time, and
  - bad economic conditions 90% of the time.
- Probabilities:
  - $P(P|g) = 0.8$, $P(N|g) = 0.2$.
  - $P(N|b) = 0.9$, $P(P|b) = 0.1$.
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Suppose a positive report came out. We want to know $P(g|P)$:

$$P(g|P) = \frac{P(g \cap P)}{P(P)} = \frac{P(P|g)P(g)}{P(P|g)P(g) + P(P|b)P(b)}$$

$$= \frac{(0.8)(0.6)}{(0.8)(0.6) + (0.1)(0.4)} = 0.923$$

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- Now use $P(g|P)$ and $P(b|P)$ to find decision that maximizes expected value. What is the expected value?
- What would your decision be if there was a negative report? What is the expected value?

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Next time...

- (Re)read the textbook on this topic (BWT, Chapter 12).
- Homework assignment: End of Chapter 12 problems 7,8,9,18,19.
    - Type up your answers and post them in D2L dropbox.
- Quiz on this topic.
- Next topic: Simulation (BWT, Chapter 14).