Faculty of Economic and Management

Gdańsk University of Technology

Decision Analysis 2024/2025

Assignment 02

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Course: Decision Analysis

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Case 1 – decision-making using decision tree

Problem Definition:

A pharmaceutical company is considering whether to develop a new drug. The drug development process involves three critical stages: animal trials, human trials, and the market launch. Each stage carries risks of failure and potential financial loss, but success at each stage leads to higher financial returns. The company needs to decide:

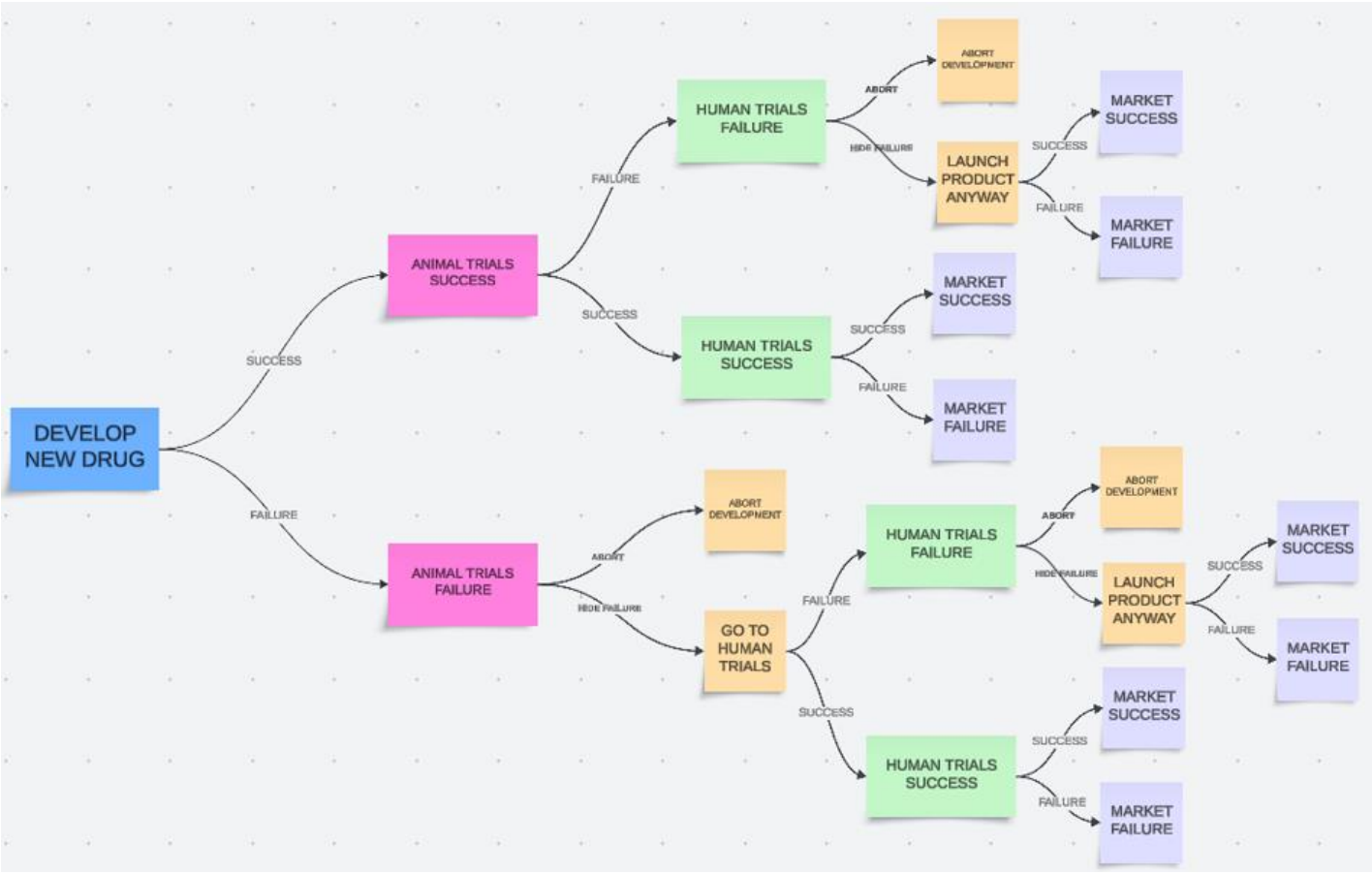
1. Whether to proceed with the drug development process at each stage.
2. How to handle failures (e.g., aborting development or attempting to mitigate losses by proceeding to the next stage).
3. Which strategy maximizes the expected financial returns (Expected Monetary Value, EMV) while minimizing risk.

Key Challenges:

- Uncertain outcomes at each stage (e.g., animal trials success rate of 70%, human trials success rate of 30%).
- High costs associated with failures at any stage/
- Ethical and financial implications of launching a product after trial failures.

The goal is to determine the optimal decision path using a decision tree and payoff table to calculate the EMV at each stage and identify the most profitable strategy.

Decision Tree Visualization:



Decision Tree as a table:

	DEVELOPING NEW DRUG (RUNNING ANIMAL TRIALS)									
	ANIMAL TRIALS FAILURE						ANIMAL TRIALS SUCCESS			
PROBABILITY	30%						70%			
PAYOFF	-100 000,00 zł						-100 000,00 zł			
EVENT PROBABILITY	30%						70%			
EMV	-100 000,00 zł						392 000,00 zł			
	ABORT DEVELOPMENT	HIDE FAILURE AND GO TO HUMAN TRIALS					HUMAN TRIALS FAILURE		HUMAN TRIALS SUCCESS	
PROBABILITY	50%	50%					30%		70%	
PAYOFF	0,00 zł	0,00 zł					-400 000,00 zł		-400 000,00 zł	
EVENT PROBABILITY	15,0%	15,0%					21,0%		49,0%	
EMV	-100 000,00 zł	-196 000,00 zł					140 000,00 zł		500 000,00 zł	
		HUMAN TRIALS SUCCESS		HUMAN TRIALS FAILURE			LAUNCH PRODUCT ANYWAY	ABORT DEVELOPMENT	MARKET FAILURE	MARKET SUCCESS
PROBABILITY		30%		70%			50%	50%	40%	60%
PAYOFF		-400 000,00 zł		-400 000,00 zł			0,00 zł	0,00 zł	100 000,00 zł	1 600 000,00 zł
EVENT PROBABILITY		4,50%		10,50%			10,50%	10,50%	19,60%	29,40%
EMV		140 000,00 zł		-340 000,00 zł			140 000,00 zł	-500 000,00 zł	-400 000,00 zł	1 100 000,00 zł
		MARKET FAILURE	MARKET SUCCESS	ABORT DEVELOPMENT	LAUNCH PRODUCT ANYWAY		MARKET FAILURE	MARKET SUCCESS		
PROBABILITY		40%	60%	50%	50%		40%	60%		
PAYOFF		-800 000,00 zł	1 600 000,00 zł	0,00 zł	0,00 zł		-800 000,00 zł	1 600 000,00 zł		
EVENT PROBABILITY		1,80%	2,70%	5,25%	5,25%		4,20%	6,30%		
EMV		-1 300 000,00 zł	1 100 000,00 zł	-500 000,00 zł	-340 000,00 zł		-1 300 000,00 zł	1 100 000,00 zł		
					MARKET FAILURE	MARKET SUCCESS			Decision node	Other colors are chance nodes
				PROBABILITY	40%	60%			Final event payoff	
				PAYOFF	-2 000 000,00 zł	1 600 000,00 zł				
				EVENT PROBABILITY	2,10%	3,15%				
				EMV	-2 500 000,00 zł	1 100 000,00 zł				

Interpretation and Key Insights

1. **Decision-Making Under Risk**:
    a. The results confirm that the profitability of developing a new drug depends on favorable probabilities at each stage. For instance:
        i. A high probability of success in animal trials (70%) makes the initial decision to proceed worthwhile.
        ii. The lower probability of human trial success (30%) is a significant bottleneck, making this stage the riskiest in terms of financial return.
2. **Risk Mitigation Options**:
    a. Animal Trials Failure: If the trials fail, the optimal decision is to abort the development, with a payoff of -100,000 zl, avoiding further losses.
    b. Human Trials Failure: After a failure in this stage, launching the product carries both financial and ethical risks. The EMV shows that aborting the project at this stage (-500,000 zl) does not minimize losses compared to launching a failed product.
3. **Profitability of Market Success**:
    a. A 60% probability of market success after successful human trials generates the highest payoff of 1,600,000 zl. Even accounting for market failure probabilities, the EMV is significantly positive, making market launch a profitable choice if prior stages succeed.
4. **Ethical and Financial Considerations**:
    a. Launching the drug after human trial failure or market failure could have reputational and legal consequences. The EMV calculations suggest that such decisions, while financially feasible in some scenarios, are suboptimal and risky.

Additional Comments

Interesting Insights:

- **Strategic Flexibility**: Decision trees show how flexible strategies (e.g., hiding failures and proceeding cautiously) can mitigate risks while keeping options open for potential profits.
- **Probabilities and Payoffs**: Minor changes in probabilities (e.g., human trial success rate increasing) have a significant impact on the overall decision.

Personal Experience:

- **Learning Decision Trees**: Constructing the decision tree and calculating EMV clarified the importance of systematic decision-making over intuition.

- **Challenges**: Assigning probabilities and payoffs required assumptions based on hypothetical data, highlighting the difficulty in accurately modeling real-world uncertainty.
- **Takeaway**: The exercise demonstrated the power of decision trees in visualizing complex decisions and identifying optimal strategies, especially in industries like pharmaceuticals where risks are high.

Case 2 - Decisions made under risk and/or uncertainty

Problem Statement

The goal is to make an investment decision among three cryptocurrencies: Bitcoin, Ethereum, and Solana. The decision is based on potential market conditions: Bull Market, Neutral Market, and Bear Market. The objective is to maximize potential returns while minimizing risks by applying decision-making methods under uncertainty and risk.

Market Condition Definitions:

- Bull Market: A period when prices are rising or are expected to rise, often driven by investor optimism and confidence in the market.
- Neutral Market: A period when prices remain relatively stable, with minimal fluctuations in either direction.
- Bear Market: A period of falling prices, often accompanied by investor pessimism and reduced market activity.

Payoff Table:

Investment	Bull Market (40%)	Neutral Market (40%)	Bear Market (20%)
Bitcoin	15,000 USD	5,000 USD	-3,000 USD
Ethereum	10,000 USD	6,000 USD	-2,000 USD
Solana	8,000 USD	3,000 USD	-5,000 USD

Decision-Making Methods Applied:

1. **Under Uncertainty:**
   - **Maximax:** 15,000 (Bitcoin)
   - **Maximin:** -2,000 (Ethereum)
   - **Laplace:** 5,667 (Bitcoin)
   - **Hurwicz (α = 0.7):** 9,600 (Bitcoin)
   - **Savage:** 1,000 (Bitcoin)

Investment	Bull Market (40%)	Neutral Market(40%	Bear Market (20%)	Maximum	Minimum	Average	Realistic	Minimum regret
Bitcoin	15000	5000	-3000	15000	-3000	5666,67	9600	1000
Ethereum	10000	6000	-2000	10000	-2000	4666,67	6400	5000
Solana	8000	3000	-5000	8000	-5000	2000	4100	7000

Minimum regret table	Bull Market (40%)	Neutral Market(40%)	Bear Market (20%)	Max Regret
Bitcoin	0	1000	1000	1000
Ethereum	5000	0	0	5000
Solana	7000	3000	3000	7000

Maximax	15000
Maximin	-2000
Laplace	5666,67
Hurwicz with alpha	9600
Savage	1000

2. **Under Risk:**

EMV (Expected Monetary Value):

- Bitcoin: 7,400
- Ethereum: 6,000
- Solana: 3,400

EOL (Expected Opportunity Loss):

- Bitcoin: 600
- Ethereum: 2,000
- Solana: 4,600

EPPI (Expected Payoff with Perfect Information): 8,000

EVPI (Expected Value of Perfect Information): 600

Investment	Bull Market (40%)	Neutral Market(40%	Bear Market (20%)	EMV	EOL	EPPI	EVPI
Bitcoin	15000	5000	-3000	7400	600	8000	600
Ethereum	10000	6000	-2000	6000	2000		2000
Solana	8000	3000	-5000	3400	4600		4600

Description of Results and Interpretation

Summary of Results:

- Based on **Maximax**, **Hurwicz**, **Laplace**, **EMV**, and **EOL**, **Bitcoin** is the optimal investment choice.
- **Ethereum** performs better under the Maximin criterion (minimizing potential losses).
- **Solana** exhibits the highest risk and least favorable outcomes across most methods.

Key Insights:

- Bitcoin provides the highest returns in a Bull Market scenario while maintaining relatively low opportunity losses.
- Although Ethereum has less downside risk compared to Bitcoin, its expected returns are lower.
- Solana is the least attractive due to high opportunity losses and the lowest EMV.

4. Additional Comments

Scope of the Problem:

This analysis simplifies cryptocurrency investment decisions by focusing on hypothetical returns. In reality, market conditions and probabilities may vary significantly due to high volatility.

Personal Experience:

Preparing this assignment highlighted the importance of structured decision-making tools. It was intriguing to observe how different methods lead to similar conclusions, providing a robust decision framework.