

Human Decision Making

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Introduction to Human Decision Making

- **Human decision making** can be simply described as **process of selecting an optimal solution among the different options**

Example:

- Selection of School for your child.
- Selection of house location before purchasing
- Selection of lottery ticket number

Daily we are making lots of decision in conscious and un-conscious state

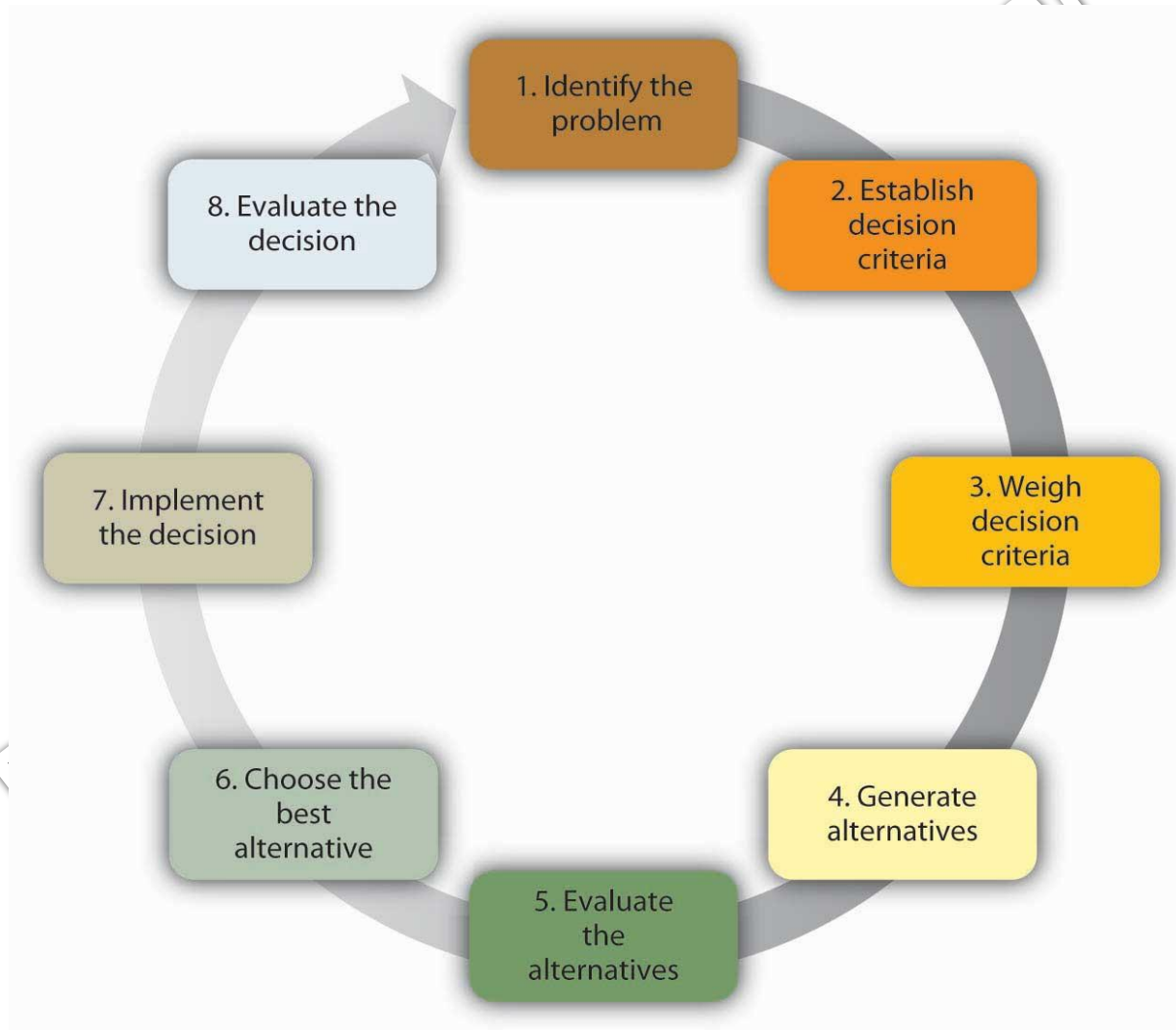


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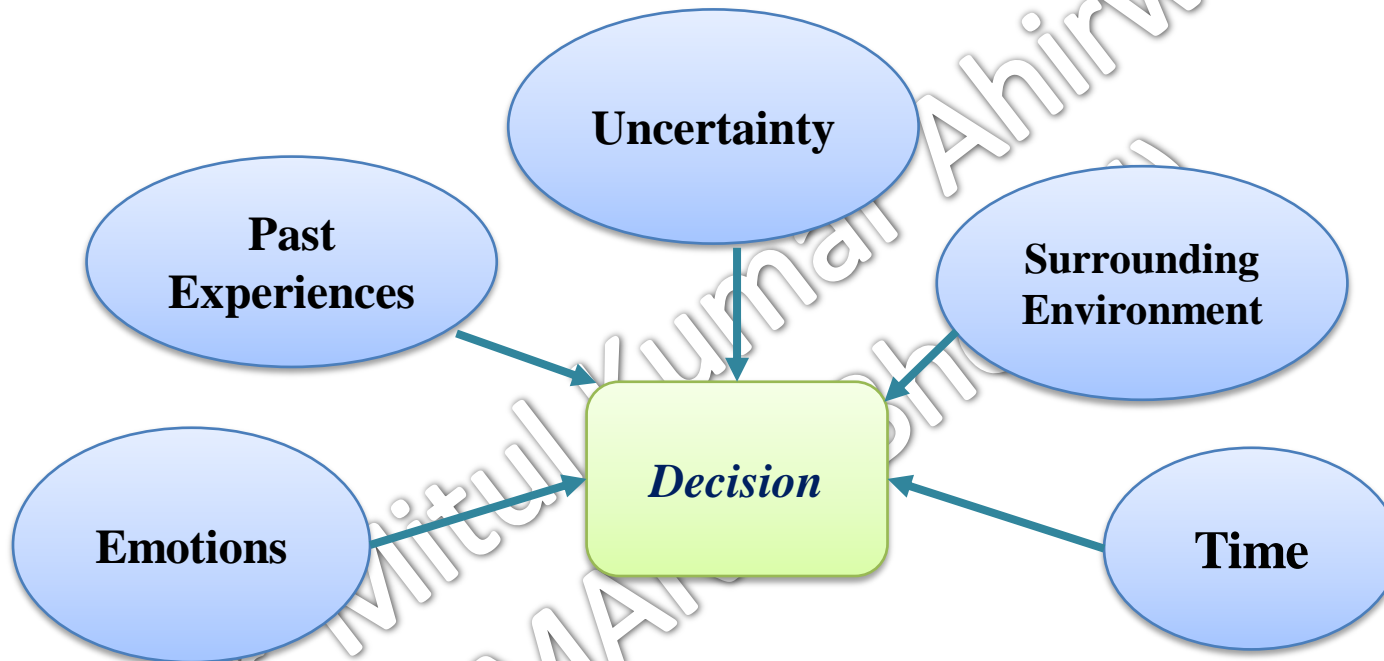
- For some decision output is **certain** and for some output is **uncertain**.
- So we use **previous experience** (that noting but previous knowledge or learning)
- With some decision, **risk is also is associated**.
- But still humans are making decisions with great accuracy.
- That's why, human decision making process is very complicated to model.
- **Because every person has its own preferences and attribute for different problems and has their solution/decision**

The Decision Making Process



Source: <https://goo.gl/images/iG29pu>

Factors Influencing the Process of Decision Making



Impact of Emotions on Decision Making

- Emotions can be categorized as:
 - a. Positive Emotions
 - b. Negative Emotions
- A model is proposed which **forecast the steps** taken by the user and help them to choose better option by considering the **emotional factor**.
- A model describes how **military command and control decision** making is influenced by the presence of **behaviour moderator like emotion and stress**.

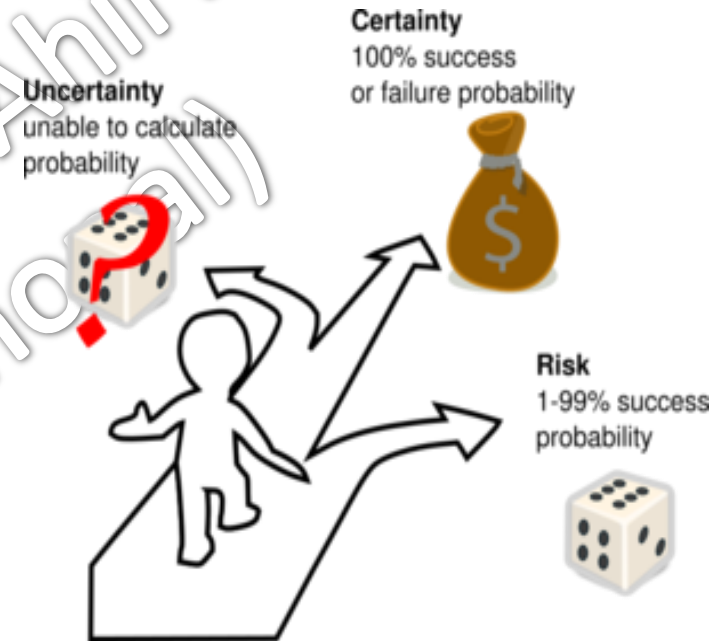


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Uncertainty of Outcome

- **Uncertainty** generally arises when there is incomplete or improper information about the future outcome .
- Various theories to model decision making under certainty / uncertainty has been proposed .
- **Utility theory and Prospect theory** are famous examples of these decision making theories.



Conditions while taking decision

Source: <https://goo.gl/images/NTf5N3>

Utility Theory (UT)

Utility refers to the **satisfaction that each choice provides** to the decision maker.

utility

the amount of satisfaction that you will get from the consumption of a product or service

util

is an abstraction because it isn't something in the physical world like an inch or a pound



util

- We can consider it as

*unit of satisfaction
or happiness*

*25 utils of satisfaction from eating a bowl of ice cream
while someone else would only get 5 utils of satisfaction*



Expected utility theory (EUT)

Expected utility theory (EUT): A major concept of decision making under risk or uncertainty, given by Daniel Bernoulli in 1738.

It states that the decision maker chooses between risky or uncertain possibilities by evaluating their **expected utility values**.

The weighted sums acquired by adding the utility values of results multiplied by their **particular probabilities**.

$$E[u(x)] = p_1 u(x_1) + p_2 u(x_2) + \cdots + p_n u(x_n) = \sum_{i=1}^n p_i u(x_i)$$

Example1

- Suppose if there are two options to win a gamble.
- **Option A** give a chance to win \$500 with certainty and
- **option B** gives a 50-50% chance to win \$1000 or nothing.
- So which option is chosen by the gambler?

- What if we are also considering, individual's wealth status.
- Like I already won \$10,000, then I am may go with option B
- So, it is necessary to includes the reference point in regards to an individual's wealth.

Example 2

- Suppose there is a choice to choose between two gambles such as
- **Gamble 1** offers you to win \$240 with 100% (certain)
- and
- **Gamble 2** there is two option: a) win \$400 with 50%
b) win \$100 with 50%.

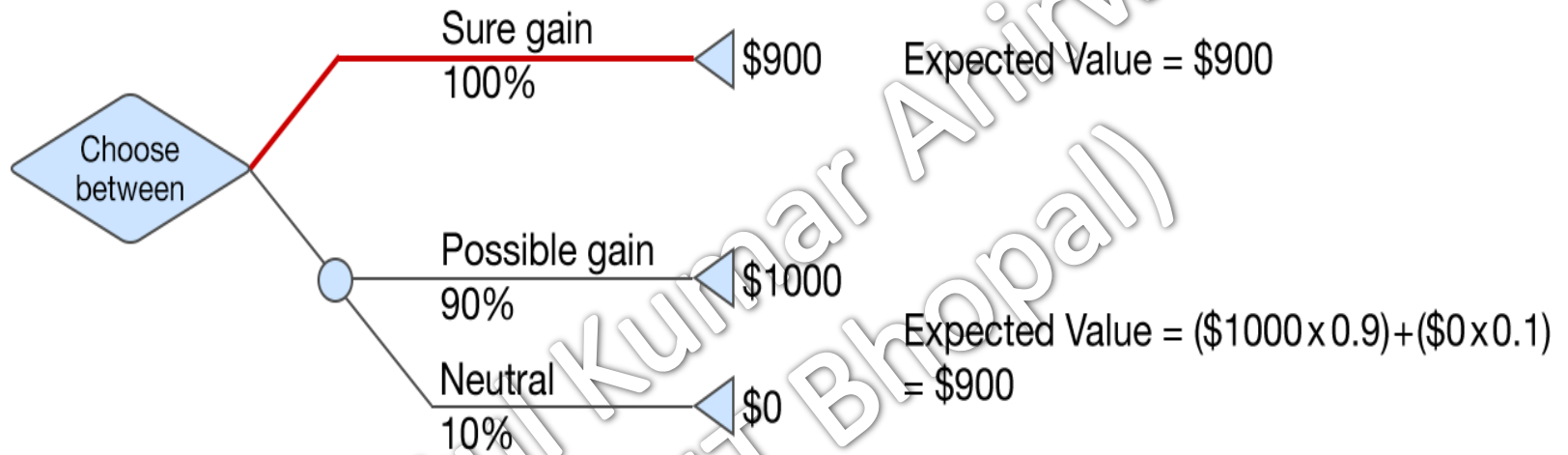
Now the question is what does expected utility theory predicts people should pick?

According to **expected utility theory**, people should have a preference for the gamble with the **highest expected utility**.

- Expected utility of **gamble 1** = $1 * 240 = 240$
- Expected utility of **gamble 2** = $(0.5 * 400) + (0.5 * 100)$
 $= 200 + 50 = 250$
- The expected utility of **gamble 2** > **gamble 1**

But people will choose **gamble 1** because it provides a gain of \$240 with certainty.

Example

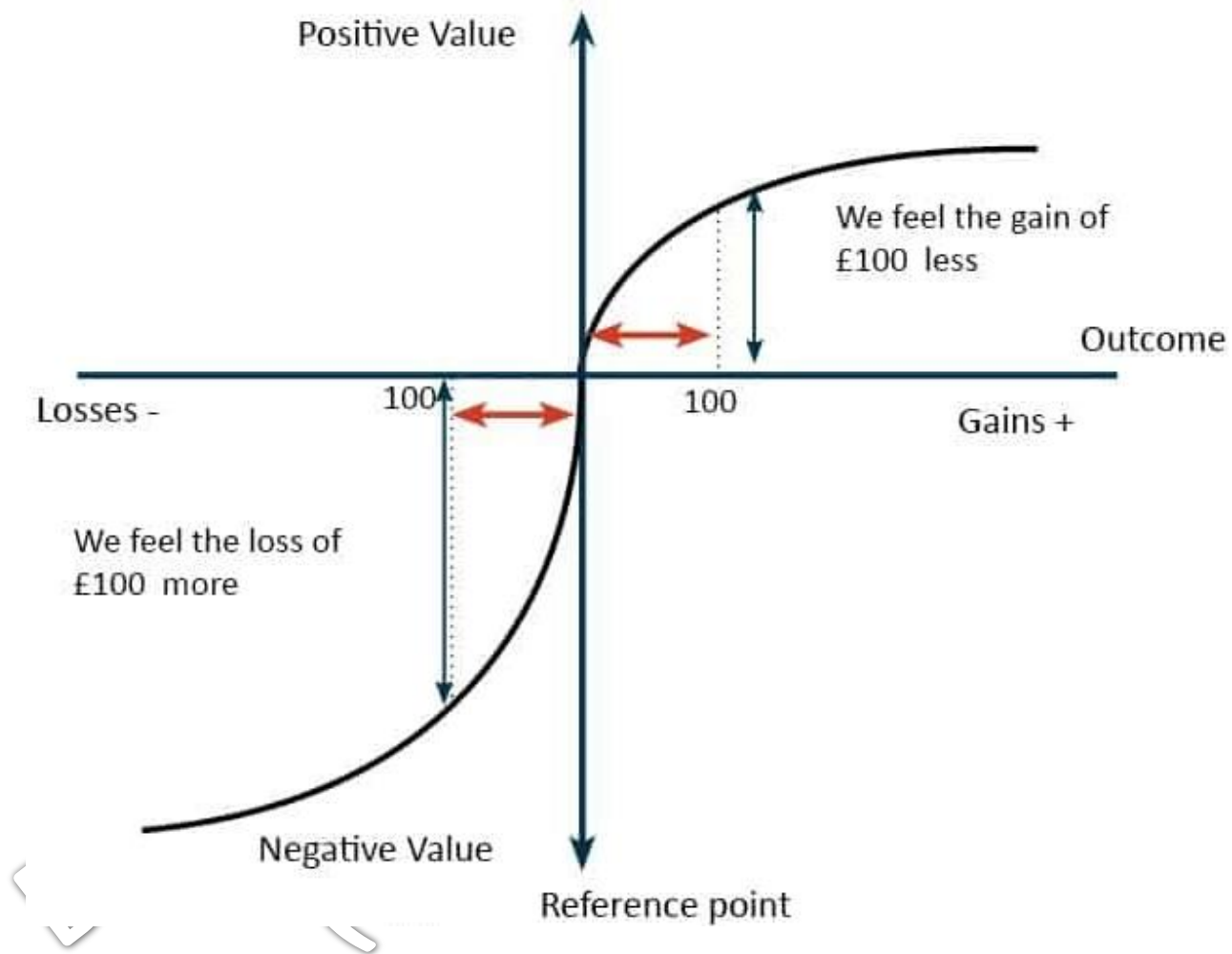


When **dealing with gains**, people are **risk averse (against)** and will choose the sure gain



When aiming to **avoid a loss**, people become **risk seeking (try)** and take the gamble over a sure loss in the hope of paying nothing.

- This **risk averse** and **risk seeking** is modelled in **Prospect Theory**.
- The **prospect theory** is an economics theory developed by *Daniel Kahneman* and *Amos Tversky* in 1979.



Graphical representation of Prospect Theory

Prospect Theory

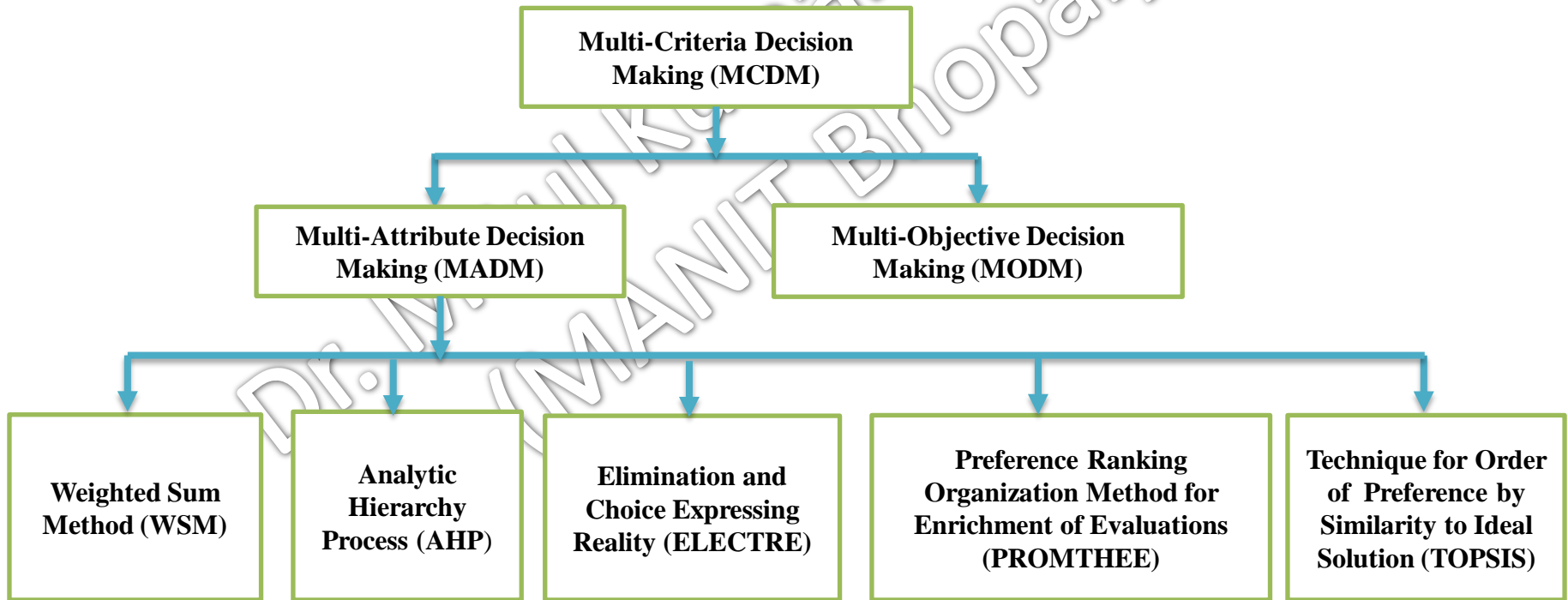
$$v(x,p) = \sum_{i=1}^n \pi(p_i) * v(x_i)$$

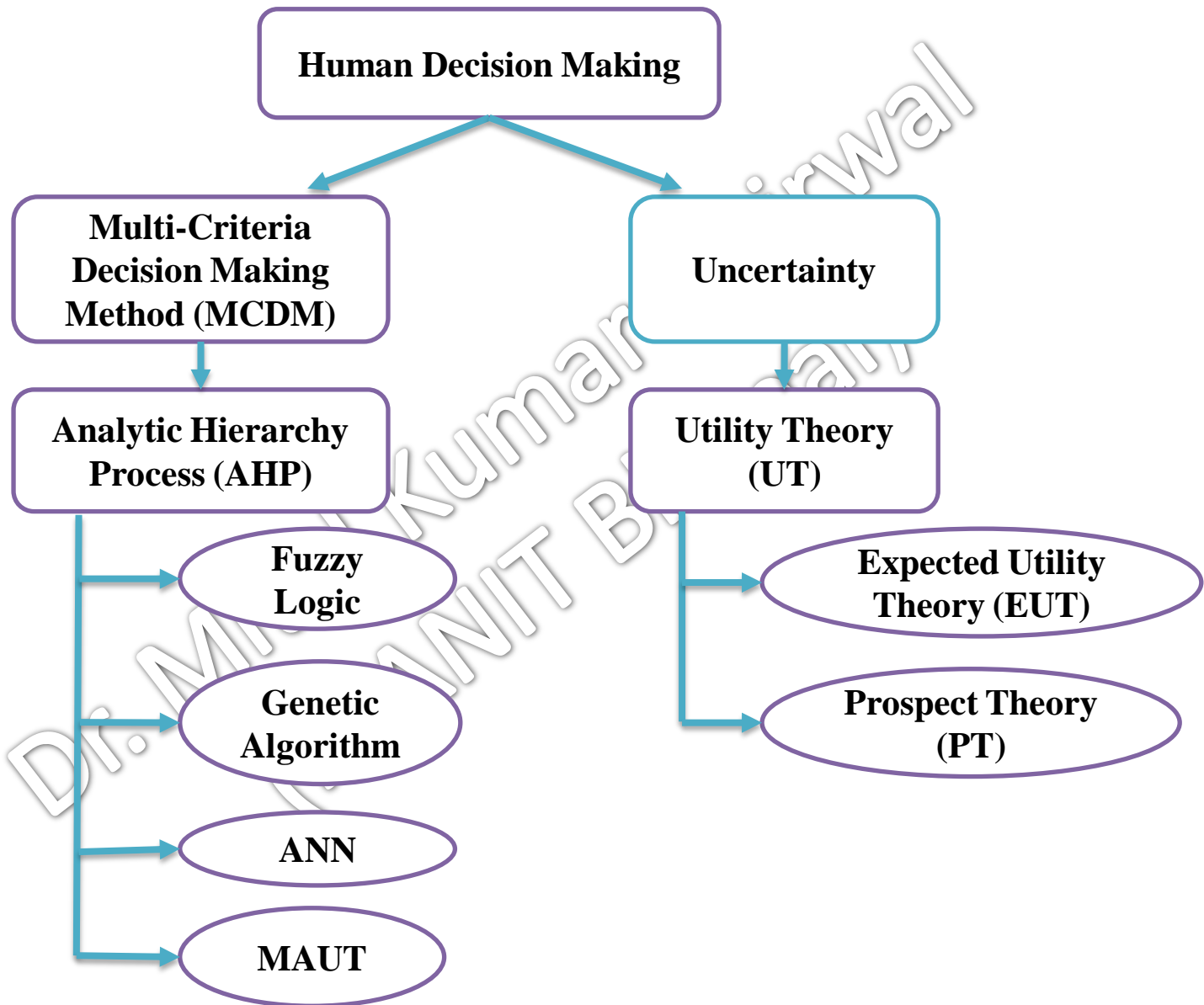
$$v(x) = \begin{cases} x^{\alpha} & \text{if } x \geq 0 \\ -\lambda(-x)^{\beta}, & \text{if } x < 0 \end{cases}$$

Where, $\lambda \geq 1$, $0 \leq \beta \leq 1$ and $0 \leq \alpha \leq 1$. The effect of diminishing sensitivity decreases as the value of α and β increases. On increasing the value of λ , the degree of loss aversion increases. As compared to gain the value function is steeper for losses, since the effect of loss stay longer as compared to gain.

Multi-Criteria Decision Making

- Also known as multi-criteria decision analysis (MCDA).
- MCDM is concerned with structuring and solving decision and planning problems involving multiple criteria.





MOTIVATION & CHALLENGES

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Motivation

- These automations are mainly governed or trained over **available data/information**.
- This automation eventually **replaces the humans by making prediction or classification** of data.
- But at present it **fails to incorporate all human factors in complete manner**.

Challenges

- Environment and circumstances are influencing the decision of an individual or group of individual. So, the incorporation of such factors is difficult task.
- Like work pressure, time limit, emotional state etc.
- In our everyday life we have to make decisions with uncertain consequences, so it is a challenge to handle uncertainty.

Reference

[Gupta, Nimisha, **Mitul Kumar Ahirwal**, and Mithilesh Atulkar. "Computational Model for Human Decision Making: A Study of Prospect Theory." 2018 Conference on Information and Communication Technology (CICT). IEEE, 2018.