# Optimisation

# Meta Heuristics

- Meta-heuristic algorithm - general method to approach a solution space by smartly searching through a set of possibilities (search space).
  - They are nature inspired algorithms, commonly used where the problem exhibits dynamic nature, and exact solutions may not be possible.
  - They find near optimal solution, so the exact (perfect) solution is not given.
- ## Multiverse Optimisation
  - Inspired from physics (Cosmology); The multiverse theory
  - Acc. to the multiverse theory more than one big bang equals more than one universe, i.e., Number of big bangs equals number of universes.
  - Multiple universes interact and collide with each other, each universe is a candidate for a solution for our problem
    - Concepts
      - White Hole
      - Black Hole
      - Worm Hole
  - ### White Hole
    - Exploration: Good solutions share their features with others.
    - Generated when parallel universes collide with each other
  - ### Black Hole:
    - Exploitation: Poor solutions absorb information from better ones.
    - As normal black holes in physics they attract anything everything, in our case bad solutions
  - ### Wormholes
    - Randomness: Solutions make random moves toward the best-known one.
    - They link various sections of universes together information travels between universes through this path.
  - ### Rules
    - Probability of a white hole increases as inflation rate increases.
    - Probability of a black hole decreases as inflation rate increases.

      > Inflation rate is determined through a fitness function used for evaluation.

    - Universes with higher inflation rate tend to send objects through white hole
    - Universes with lower inflation rate tend to send objects through black hole

- **Regardless** of inflation rate objects in all universes may experience random movement towards best universe via wormholes

# Mathematical Modelling

> Roulette mechanism used to describe the model of white and black holes along with wormholes.

## Model of Universe

- $$\begin{pmatrix} x_1^1 & \cdots & x_1^d \\ \vdots & \ddots & \vdots \\ x_n^1 & \cdots & x_n^d \end{pmatrix}$$
- $$d \implies \text{Number of Parameters}$$
- $$n \implies \text{Number of Universes}$$

- Wormhole existence probability - WEP
  - $$WEP = min + l * \left( \frac{max - min}{L} \right)$$
  - $$l \implies \text{current iteration}$$
  - $$L \implies \text{max iteration}$$
  - $$min = 0.2, max = 1.0 \text{ usually}$$
- Travelling Distance Rate - TDR
  - $$TDR = 1 - \left( \frac{l^{1/p}}{L^{1/p}} \right)$$
  - $$p \implies \text{Called exploitation accuracy usually } 6$$

# Algorithm

- We provide the population size and max iterations.
- It gives best universe its fitness value or inflation rate.
- Step 1: Initialise Parameters.
- Step 2: Compute fitness value for each universe select best universe.
- Step 3: Update WEP and TDR for each universe.
- Step 4: Select 1 universe among N by roulette wheel mechanism as white hole.

- Step 5: Use wormholes as a tunnel for object exchange between different universes.
- Step 6: Repeat until stopping criteria matched.

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## References


Learn Multiverse Optimization Algorithm Example Step-by-Step Explanation ~xRay Pixy 🌞🌍🌌🌿 - YouTube

Multiverse Optimization Algorithm in Additive Manufacturing