SNS COLLEGE OF ENGINEERING

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING IOT Including CS&BCT

COURSE NAME : DISTRIBUTED LEDGER TECHNOLOGY

TOPIC: Evolutionary Stable Strategies (ESS

Introduction to Evolutionarily Stable Strategies (ESS)

An Evolutionarily Stable Strategy (ESS) is a strategy that, if adopted by a population, cannot be replaced by an alternative strategy due to natural selection pressures. It ensures that a strategy will remain dominant over time, as long as it outperforms or is equally effective as any invading strategy. The concept was introduced by John Maynard Smith and George R. Price in the 1970s to explain the stability of behaviors and strategies in evolutionary biology.

Key Characteristics of an ESS

An ESS is defined by a few important characteristics:

1. Dominance: An ESS must perform better against itself or be equally effective against any other strategy in the population.
2. Invasibility: No other strategy can invade the population when most individuals adopt the ESS. Even if a small group of individuals adopts a new strategy, the ESS must be resilient to it.
3. Payoff Comparison: The payoffs (outcomes) when two players choose the same strategy should be at least as good as the payoffs when they choose different strategies.

Mathematically, for a strategy SSS to be evolutionarily stable, it must satisfy the condition:

- If a population is playing strategy SSS, then the payoff for SSS against itself must be greater than the payoff for an alternative strategy TTT against SSS.

Example of Evolutionarily Stable Strategy

A classic example of an ESS can be seen in the hawk-dove game, a model used in evolutionary biology to explain aggressive and cooperative behaviors. In this game, two individuals compete over a resource, and they can either act as a hawk (aggressive) or a dove (peaceful).

- If both are hawks, they fight and may be injured.
- If one is a hawk and the other is a dove, the hawk wins the resource.
- If both are doves, they share the resource.

In a population of hawks and doves, the hawk strategy is not an ESS, because a population of only doves would perform better against a single hawk. The dove strategy is stable, as it avoids the costs of aggression and has a higher payoff when there are more doves around.

ESS and Real-World Applications

The concept of ESS is widely applicable:

- In biology, it explains how certain behaviors (e.g., cooperative behavior, territorial defense) evolve and persist in populations.
- In economics, ESS can help explain stable market strategies and consumer behaviors.
- In sociology, it offers insights into how social norms and cooperative behaviors can emerge and stabilize in societies.
- In cybersecurity, the concept can be applied to strategies in network defense, where a certain security measure may evolve to be resistant to most forms of cyber attacks.