

Systems Analysis in Construction

CB312

Construction & Building Engineering Department- AASTMT

by

Ahmed Elhakeem & Mohamed Saeid



Game Theory

Definition of *Games*

Elements and properties of games

Different game types

Finding equilibrium

Prisoners Dilemma

| | | Player 2 | |
|----------|-----------|-----------|--------|
| | | Cooperate | Defect |
| Player 1 | Cooperate | 1,1 | 9,0 |
| | Defect | 0,9 | 5,5 |

Payoff Table

Game Theory

Games can be defined as a system where players take strategic decisions to maximize their utilities.

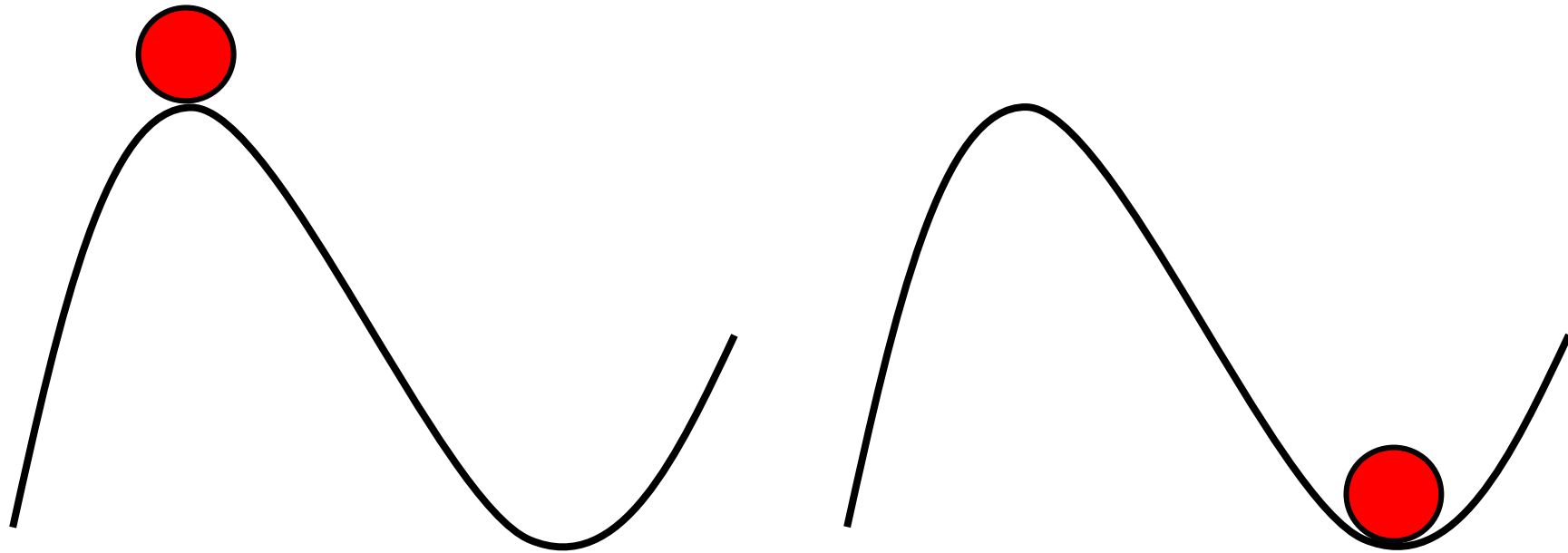
Game Theory

In game theory, a player does not play against nature, but against another *rational* player.

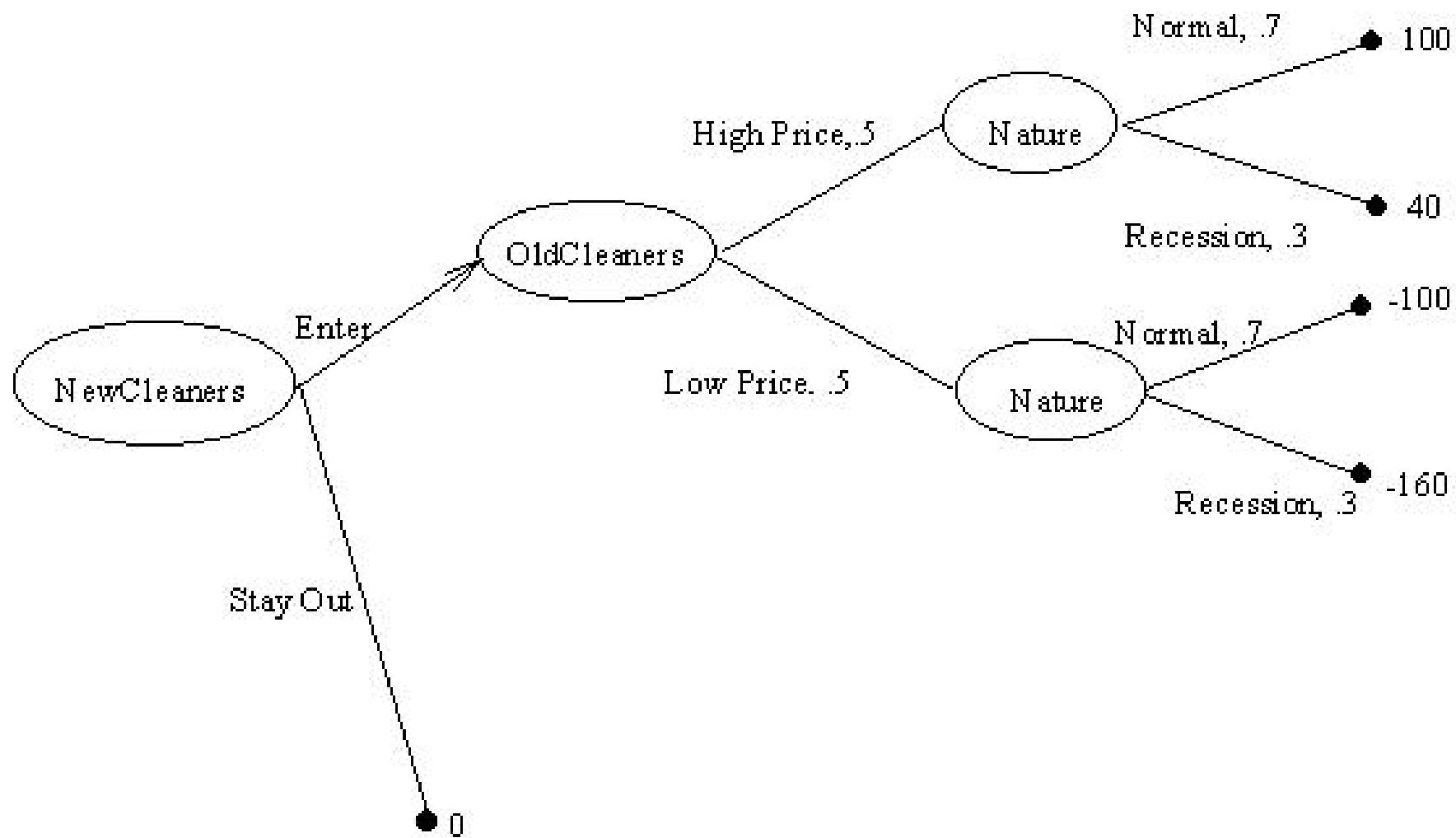
Unlike decision theory, game theory does not seek merely optimality for a player, but equilibrium.

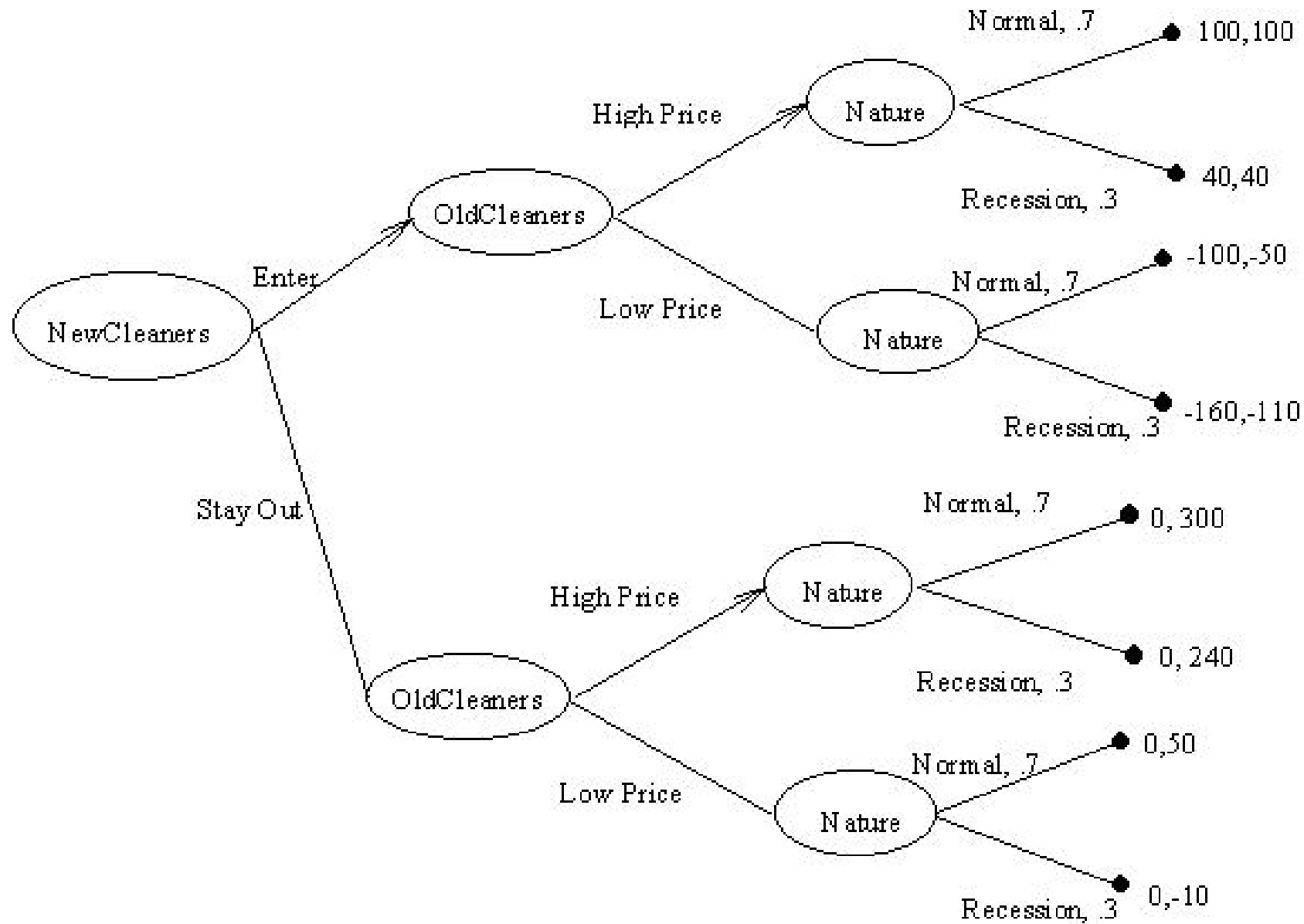
Game Theory

Equilibrium vs. Optimality.



Example of difference between
decision analysis and game
theory





Game Theory

In game theory, we care about how people (players) will decide on their actions, given the payoffs of their interactive strategies.

In other words, we evaluate a system of players competing or cooperating to achieve their goals.

Key Elements of any Game - PAPI

Players

Actions

Payoff

Information

Types of games

One shot vs Repetitive

Deterministic vs Stochastic

Simultaneous vs Sequential

Examples on games

Prisoners' dilemma

Rock, paper, scissors

Cheating game

Bidding

Strategy profiles

- A strategy (s_i) is the action taken by one player (i) against another
- A strategy profile is a mix of strategies between players

$$(s_1, s_2, \dots, s_i, s_{i+1}, \dots, s_n)$$

$$(s_i, s_{-i})$$

Types of Equilibrium mechanics

- Dominate Strategies
 - Strong and weak
- Iterated Dominate Strategies
- Nash Equilibrium

Dominated Strategies

- A dominated strategy is a strategy in set S_i that no other strategy can provide better outcome for player i , regardless of the strategies used by other players.

$$\pi_i(s_i^*, s_{-i}) \geq \pi_i(s_i', s_{-i}) \quad \forall s_i^* \neq s_i'$$

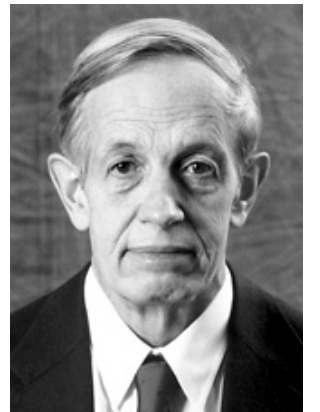
- Prisoner dilemma

Nash Equilibrium

- Nash equilibrium is the most recognized and stable strategy profile.
- A strategy profile is a Nash Equilibrium (NE) if no player has an incentive to deviate from his strategy given that the other players do not deviate.

$$\forall i, \quad \pi_i (s_i^*, s_{-i}^*) \geq \pi_i (s_i', s_{-i}^*), \quad \forall s_i'$$

- NE is the best response of the players to each others.



John Nash (1928 – 2015)

Prisoners Dilemma

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|----------|-----------|-----------|--------|
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Payoff Table

Battle of the Sexes

| | | Bob | |
|-------|--------|--------|--------|
| | | Ballet | Soccer |
| Alice | Ballet | 2,1 | 0,0 |
| | Soccer | 0,0 | 1,2 |