

## 6-Practice

**Theme:** Developing Negotiation Strategies: Modeling

**Objective:** The aim is to introduce students to the concept of negotiation strategies in multi-agent systems, and to teach them how to model decision-making and resource allocation processes among agents. The focus is on enhancing students' practical experience in inter-agent cooperation, agreement, and competition mechanisms through hands-on application.

### Theory:

Negotiation plays a crucial role in multi-agent systems because agents need to make autonomous decisions to allocate resources, coordinate actions, or reach a common agreement. Negotiations can be cooperative (collaborative) or competitive.

Negotiation strategies are often applied in the following situations:

- **Resource allocation:** For example, dividing market shares among companies.
- **Conflict resolution:** For example, reaching an agreement on salary between an employer and an employee.
- **Collaboration:** For example, forming trade agreements between countries.

### Types of Negotiation

#### 1. Cooperative Negotiation

Agents act together to reach common benefits and agree on joint actions.

**Examples:** Autonomous drones coordinate to choose the most efficient delivery routes. Sensor networks distribute signals to save energy.

#### 2. Competitive Negotiation

Agents aim to maximize their own benefits.

**Examples:** In an auction system, buyers try to get the best price. Companies compete for market share in a corporate competitive environment.

### Negotiation Strategies

- **Hard Strategies** - The agent does not compromise and defends its position to the end. **Disadvantage:** Negotiations may fail. **Example:** Refusing to lower the price and forcing only its own terms.

2. **Flexible Strategies**- The agent is willing to compromise but tries to preserve its own interests. **Example:** Gradually lowering the price, proposing alternative options.

- **Iterative Negotiation** - Agents exchange offers step by step to reach an optimal agreement. **Example:** Bargaining over a house price – the buyer and seller gradually reach an agreement.

Practice:

In this example, two agents (Agent A and Agent B) conduct negotiations to allocate resources. Each agent makes proposals, responds to counteroffers, and agrees on a common deal.

**Negotiations started:**

**Agent A -> Agent B:** I offer 15 resources.

**Agent B:** I counter your offer: 10 resources.

**Agent A:** Counteroffer accepted!

**Agent A:** Trade completed. Current resources: 40

**Agent B -> Agent A:** I offer 10 resources.

**Agent A:** I counter your offer: 8 resources.

**Agent B:** Counteroffer accepted!

**Agent B:** Trade completed. Current resources: 38

```
import random

class Agent:
    def __init__(self, name, resources):
        self.name = name
        self.resources = resources # Current amount of resources

    def make_offer(self, other_agent, offer):
        """Make an offer"""
        print(f"{self.name} -> {other_agent.name}: I offer {offer}
resources.")
        return other_agent.counter_offer(offer)

    def counter_offer(self, offer):
        """Make a counter-offer"""
        if offer > 0 and self.resources >= offer:
            counter = offer - random.randint(1, 5) # Adjust the
counter-offer
            if counter <= 0:
                counter = 1 # Set a minimum offer
            print(f"{self.name}: I modified your offer: {counter}
resources.")
            return counter
        else:
```

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        print(f"{self.name}: Offer rejected!")
        return 0

def accept_counter_offer(self, counter_offer):
    """Accept or reject the counter-offer"""
    if counter_offer > 0 and self.resources >= counter_offer:
        print(f"{self.name}: Counter-offer accepted!")
        return True
    else:
        print(f"{self.name}: Counter-offer rejected!")
        return False

def trade(self, other_agent, offer):
    """Execute the trade"""
    counter = self.make_offer(other_agent, offer)
    if counter > 0:
        if self.accept_counter_offer(counter):
            self.resources -= counter
            other_agent.resources += counter
            print(f"{self.name}: Trade completed. Current
resources: {self.resources}")
        else:
            print(f"{self.name}: Trade did not occur.")
    else:
        print(f"{self.name}: No counter-offer received.")

# Main program
if __name__ == "__main__":
    agent_a = Agent("Agent A", 50) # Agent A has 50 resources
    agent_b = Agent("Agent B", 30) # Agent B has 30 resources

    print("Negotiations started:")
    agent_a.trade(agent_b, 15) # Agent A offers 15 resources to Agent
B
    agent_b.trade(agent_a, 10) # Agent B offers 10 resources to Agent
A

```

## Result

```

[initiator] Request sent: Please make an offer!
[responder] Request received: Please make an offer!
[responder] Offer sent: 75
[initiator] Offer received: 75
[initiator] Negotiation completed: Agreement reached!

```