

# Coordination Tasks and Agent Cooperation

# Coordination Tasks

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- A Scouting Coordination
- B Harvesting Coordination
- c Vehicle Coordination

# Cooperation Mechanisms

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## **Deliberative**

- 1 PGP / GPGP
- 2 Coalitions

## **Negotiators**

- 3 Contract Net
- 4 Auctions
- 5 Voting

## **PGP**

Each agent creates a local plan

Agents exchange local plans and generate PGP by combining local partial plans

Optimise PGP: analyse received information

## **GPGP**

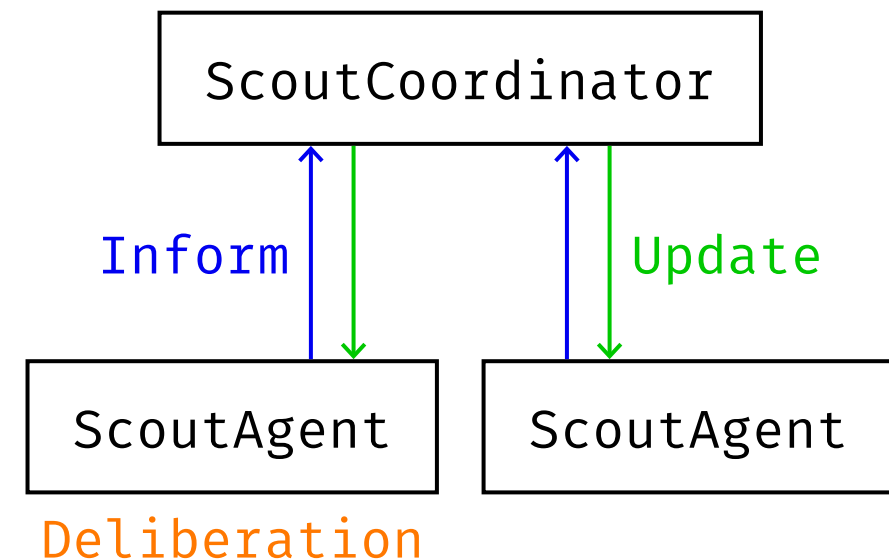
Domain-independent extension

## Scouting Coordination

1 ScoutAgents decide their own paths (local plans)

2 ScoutCoordinator collects local plans and builds PGP

3 ScoutCoordinator checks for conflicts, returns modified PGP



# PGP / GPGP — Advantages and Disadvantages

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- + Flexibility in a dynamic environment
- + Efficiency: elimination of conflicts and redundancy
- Complexity

# Coalitions

Several agents work together in a coalition

Achieve tasks that could not be achieved individually

Complete tasks more efficiently

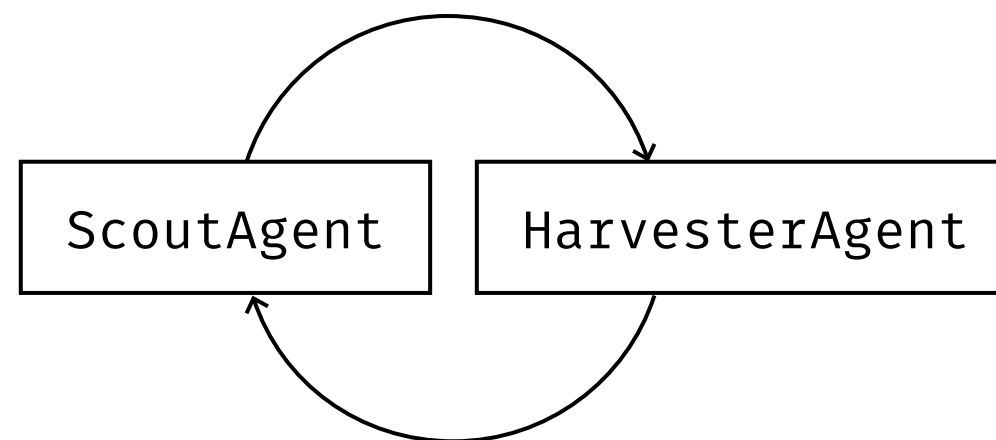
# Coalitions — Applicability

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## Vehicle Coordination

Vehicles, that come close to each other,  
enter in a coalition

Objective is to move on fast and  
efficiently without colliding





# Coalitions — Pros and Cons

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- + Coalitions can prevent collisions
- A lot of communication
- When to form a coalition?
- Which mechanism to use?

# Contract Net

Based on the way in which companies put contracts out to tender

Five phases:

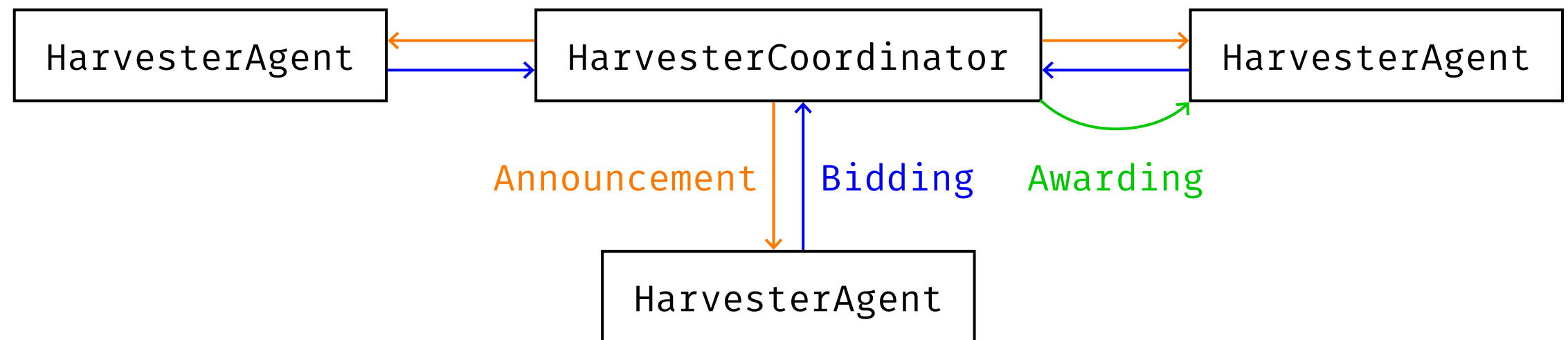
- 1 Recognition
- 2 Announcement
- 3 Bidding
- 4 Awarding
- 5 Expediting

# Contract Net — Applicability

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## Harvesting Coordination

- 1 HarvesterCoordinator announces garbage
- 2 HarvesterAgents submit tenders
- 3 HarvesterCoordinator assigns task to one or more



# Contract Net — Pros and Cons

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- + Garbage collection is dividable into subgoals
- + Garbage collection subgoals are complex, it makes sense to distribute them efficiently
- Computational effort (deliberation)
- Time delay (exchange of messages)

# Auctions

Allocate goods/resources among competing self-interested parties

English

Dutch

First price sealed bid  
(FPSB)

Vickrey

Multi-unit

Multi-attribute

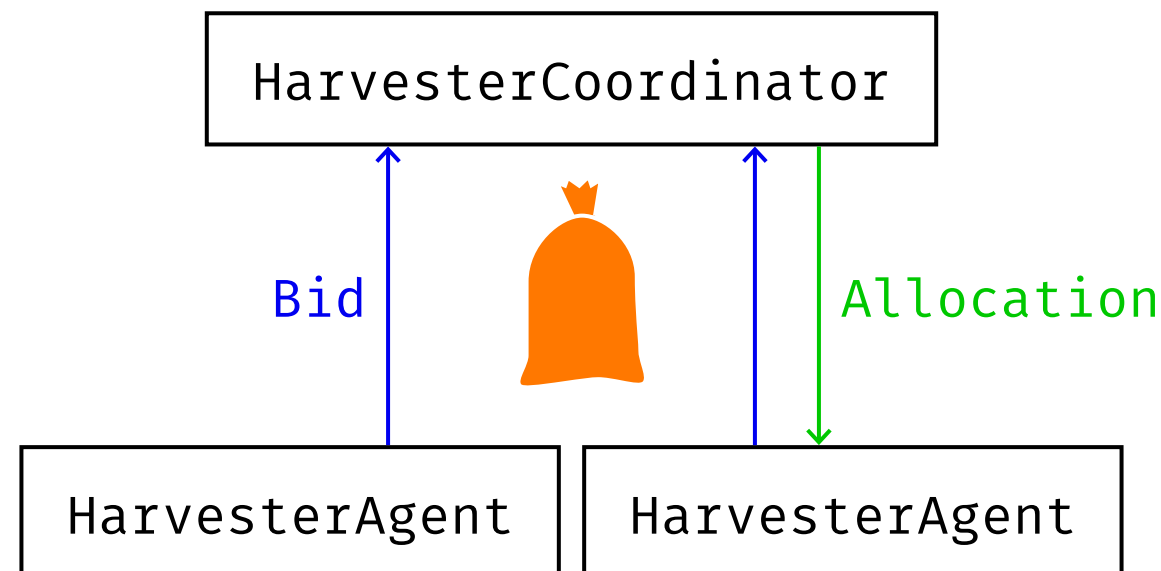
Combinatorial

# Auctions — Applicability

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## Harvesting Coordination: FPSB

- 1 Auctions of each group of garbage
- 2 HarvesterAgents bid (based on their current state, load, distance from garbage)
- 3 HarvesterAgent allocates tasks to one or more



# Auctions — Pros and Cons

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- + Multi-attribute auctions would allow for allocation based on additional attributes/information
- Agents are not self-interested and competitive, but want to reach a common goal together

# Voting

Distributed deliberation process,  
decisions are taken collectively

Simple voting

Plurality, Anti-plurality, Best-worst, Approval

Total order voting

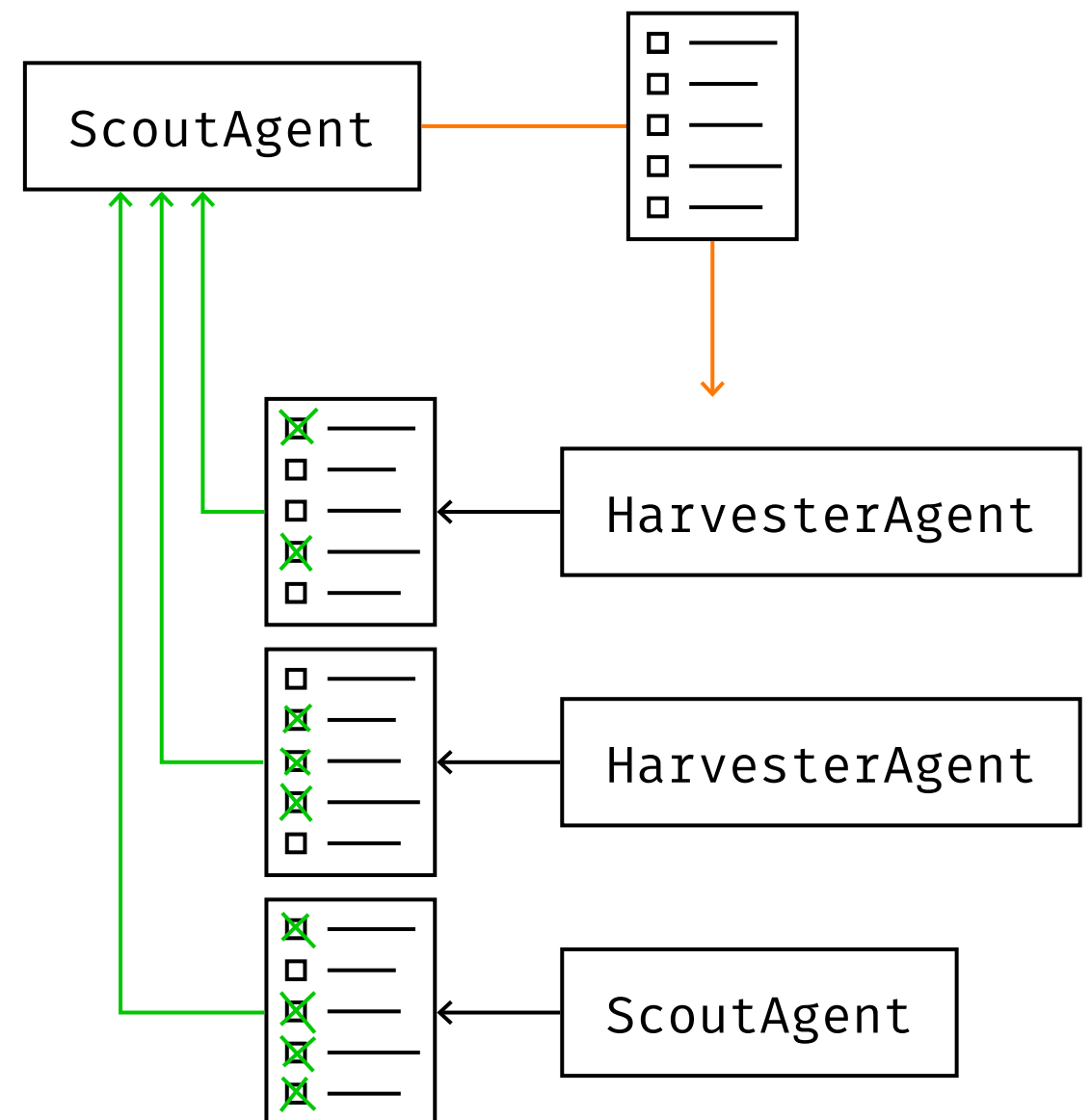
Binary, Borda, Condorcet



## Vehicle Coordination: Approval Voting

1 Each vehicle puts a list of possible routes to a public vote

2 Other vehicles approve those paths that do not interfere with their own route



# Voting — Pros and Cons

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- + Agents have different destinations (objectives), and their decisions affect others
- + Equality principle: each vote has same weight
- Many vehicles have to determine their route at the same time: we need an order
- Unnecessary high computational cost to calculate alternative routes

# **Coordination Tasks**

A Scouting Coordination

B Harvesting Coordination

c Vehicle Coordination

# Scouting Coordination

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## **Problem**

Multi-agent patrolling problem

## **Solution**

TSP-based single cycle approach

ScoutAgents patrol along a round-trip through all important cells on the map, within equal distance from each other

GPGP is used to achieve and uphold equidistance (e.g. after collisions)

# Harvesting Coordination

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## **Subproblem**

Priorities of pending  
unassigned garbage

Assign garbage to  
HarvesterAgents

Idle HarvesterAgents

## **Solution**

Approval voting

Contract Net

Coalition

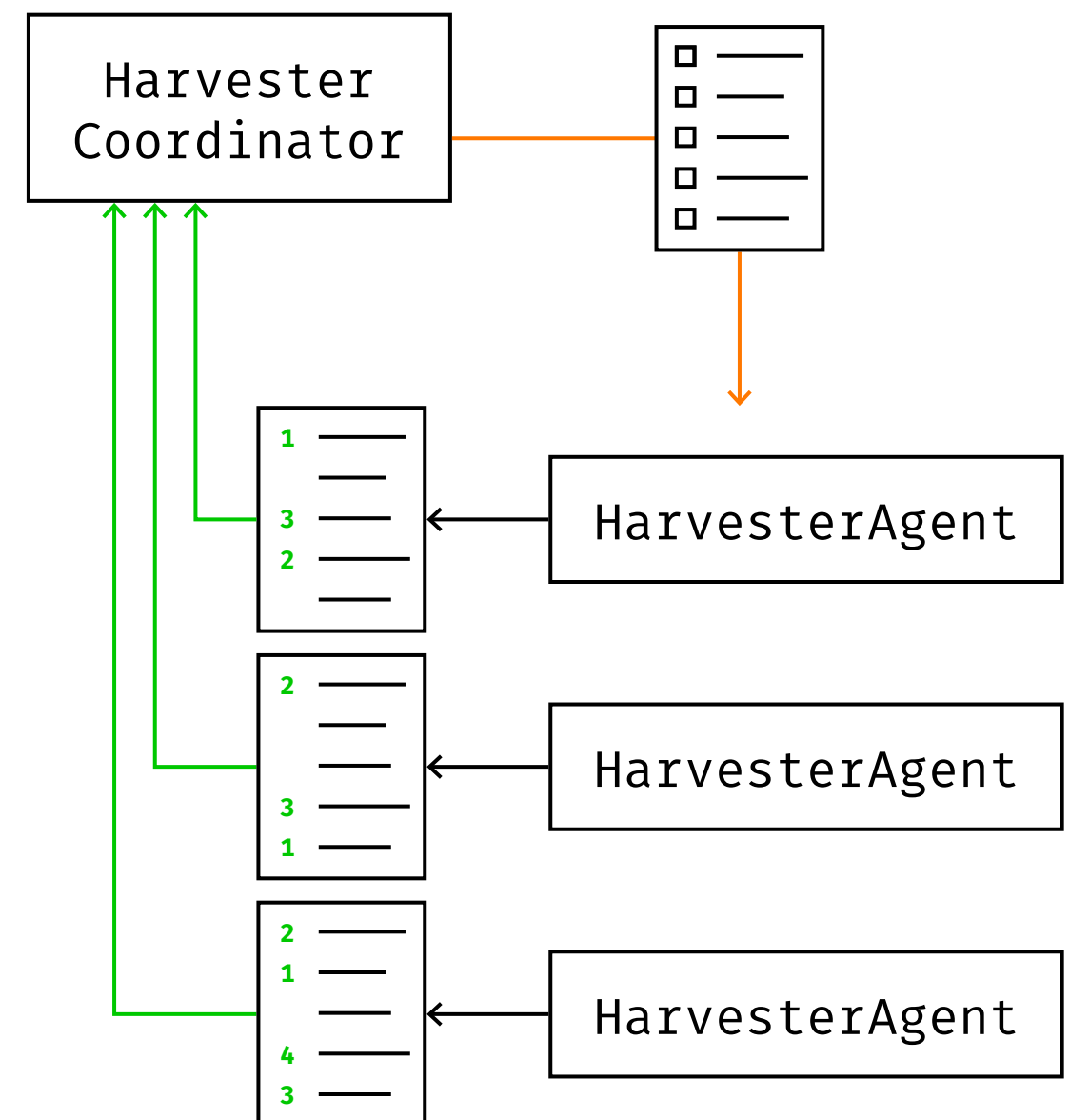
# Harvesting Coordination — Garbage Priorities

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## Approval Voting

1 HarvesterCoordinator announces list of pending unassigned garbage

2 HarvesterAgents vote, returning list ordered by their preference

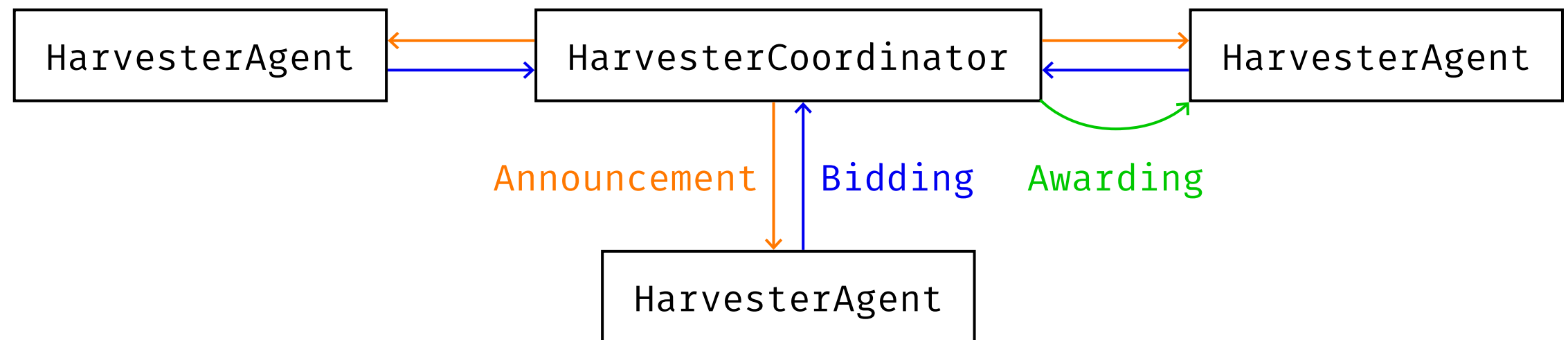


# Harvesting Coordination — Assign Garbage

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## Contract Net

- 1 Each garbage (in previously determined order) is separately announced
- 2 HarvesterAgents submit tenders
- 3 HarvesterCoordinator assigns garbage



# Harvesting Coordination – Idle HarvesterAgents

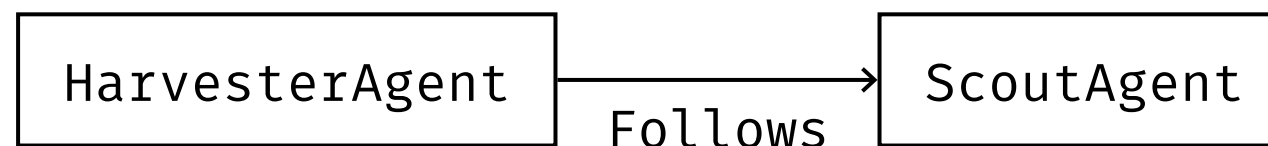
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## Coalition

Idle HarvesterAgents

Form a coalition with a ScoutAgent

Follow them around, to be closer to newly detected garbage





# Vehicle Coordination

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## **Problem**

Avoid vehicle collision

## **Solution**

CoordinatorAgent administers GP GP

Has partial plan of all vehicles' paths and actions

Resolves possible collisions and returns updated plans to respective vehicles

# Vehicle Coordination

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## **Solution**

*P* Hierarchy of vehicle priorities

- 1 Vehicle already moving to avoid collision
- 2 HarvesterAgent moving to recycling centre (to recycle garbage)
- 3 HarvesterAgent moving to garbage location (to harvest garbage)
- 4 ScoutAgent
- 5 HarvesterAgent idle

# Vehicle Coordination

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## **Solution**

For each vehicle:

Max  $P$  (Vehicle 1, Vehicle 2)

Continue moving on current path

¬Max  $P$  (Vehicle 1, Vehicle 2)

Go back on previous path taken until no longer in current path of prioritised vehicle. Remain stationary until prioritised vehicle is out of path. Move again on original path.

## **Group 7**

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