

# Supply Chain Management League (OneShot): An Overview

SCML Organizing Committee:

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## Abstract

The purpose of this document is to provide an overview of the Automated Negotiation Agent Competition (ANAC) Supply Chain Management League OneShot track (SCML-OneShot). The game is intended to further research on agent negotiation. As such, the design emphasizes negotiation and de-emphasizes operations (e.g., production, scheduling, etc.).

The SCM world simulates a supply chain consisting of multiple factories that buy raw materials from, and sell final products to, one another. The factories are managed by autonomous agents. These agents are assigned a target quantity (drawn at random) to either buy or sell. They then negotiate with other agents to reach agreements, which become binding contracts that specify the terms of trade.

A simulation comprises multiple days, during each of which the one-shot game is played. All agents have the same goal each day, namely to turn a profit. The agent with the highest total profit summed over all days, and then averaged across multiple simulations, wins. During a single simulation, learning is permitted from one day to the next; however, learning is not permitted across simulations.

**Products** There are three product types: a raw material, an intermediate product, and a final product.

**Production** There are two manufacturing processes, one for converting the raw material into the intermediate product, and a second for converting the intermediate product to the final product.

**Factories** Factories convert input products into output products by running their manufacturing processes on their production lines. All processes run convert exactly one unit, **instantaneously**, at a predefined cost.

**Production Graph** Factories are organized in two layers  $L_0$  and  $L_1$  (Fig. 1).  $L_0$  factories receive exogenous contracts to buy the input (raw material), and then negotiate with  $L_1$  factories to sell them the intermediate product.  $L_1$  factories receive exogenous contracts to sell their output (final product), and then negotiate with  $L_0$  factories to buy the intermediate product.

**Agents and Negotiation** The agents in the SCM world function as **factory managers**, controlling the negotiations between  $L_0$  and  $L_1$  factories. They negotiate to reach agreements to buy and sell the intermediate product, which become binding as contracts. Such agreements are generated via bilateral negotiations using a variant of the **alternating offers protocol**, typical of ANAC competitions. Each offer specifies a **buyer, a seller, a quantity, and a unit price**. The sequences of offers and counteroffers in a negotiation are private to the negotiating parties.

All negotiations concern two issues:

**Quantity:** an integer between 1 and  $N_l$ , where  $N_l$  is the number of lines in each factory<sup>1</sup>.

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<sup>1</sup>All agents have the same number of lines in 2021.



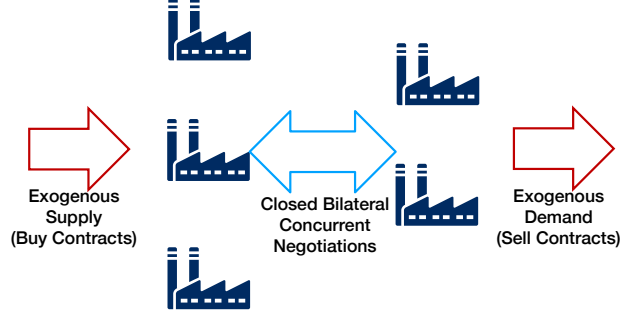


Figure 1: SCML-OneShot world. Each factory receives a single exogenous contract every time-step and its goal is to negotiate with its consumers or suppliers in order to maximize its profit.

**Unit Price:** an integer between 1 and  $\lceil \eta \text{ tp} \rceil$ , where  $\eta > 0$  is a configuration parameter (e.g., 2) and  $\text{tp}$  is the trading price of the intermediate product.

**Delivery dates are not a negotiation issue**, as all products are assumed to be delivered on the same day.

Production costs, disposal costs, and penalties are private information: i.e., no factory knows the values of any of these for any other factory (but the distributions from which they are sampled are known).

**Utility Functions** The utility function of an agent specifies its preferences over possible outcomes of a negotiation. **The utility function of an agent is simply the total revenue it receives from any sales less its total expenses**, which include the cost of the input product, production costs, and disposal costs, and shortfall penalties.

The costs and penalties on which the utility function depends are private information, known only to the concerned agent.

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**Trading Price** The **trading price** ( $\text{tp}$ ) of a product is a weighted average of its past prices, which weighs newer contract prices more heavily than older ones. The trading price is used by the system to set the price range of all negotiations, and for calculating penalties.

**Balances** Factories have an associated wallet—seeded at the start of the game with some finite balance—from which they withdraw to pay for supplies, etc., and into which their sales revenue is deposited.

**Bulletin Board** The SCM world contains a world-readable **bulletin board** that conveys both static and dynamic information about the game environment and all factories over the course of the simulation.

The static information includes the **game settings** (e.g., number of simulated days), and product information, namely a list of the consumers and producers of all products (i.e., all factory’s positions in the production graph), and the initial trading prices (called catalog prices).

The dynamic information includes a **trading price list** (per product), which reports a weighted average of each product’s past prices; and a financial reports section (also per agent), which is updated only periodically, that summarizes the financial standing of all factories (e.g., their balances).

Finally, the bulletin board also contains an **exogenous contract summary**, which reports the total quantity and average unit price of exogenous contracts each day.

<sup>2</sup>The full game description defines a  $\text{ufun}$  for a general factory with both exogenous inputs and outputs, as well as negotiated sales and purchases.

**The Simulation** Each simulation of the SCM world runs for multiple (say, 100) days. Before the first day, each agent is assigned a private production cost ( $m_f$ ). During each day:

1. The world generates exogenous contracts and samples disposal costs and delivery penalties for all agents from their corresponding distributions.
2. Agents engage in multiple (say, 20) rounds of negotiations with their negotiating partners. They can also read the bulletin board.
3. All contracts are executed: i.e., products are moved from the seller’s inventory to the buyer’s, and money is moved from the buyer’s account to the seller’s<sup>3</sup>.
4. The bulletin-board is updated, most notably to reflect new trading prices, updated financial reports, and the day’s exogenous contract summaries.

**Differences from SCML 2020** The OneShot game is a simplification of the SCML standard game, designed to de-emphasize long-term production and planning, and instead emphasize negotiations.

The design of SCML-OneShot ensures the following:

- The profit of an agent at a given step is completely determined by the set of contracts it gets at this step and does not depend in future or past negotiations.
- Agents can learn over time about their negotiation partners.

## 1 Tournament Mechanics

**How to Participate** To participate in the Supply Chain Management League (SCML), all you need to do is write and submit code for an autonomous agent that acts as a factory manager. While the production graph will be a chain in SCML2021, with agents managing but one factory with identical lines, your agent should be robust enough to manage any such factory with any manufacturing profile (i.e., any factory assignment and production cost), because its particular profile will vary from simulation to simulation.

**How to Compete** There will be three separate tracks in SCML2021. This document pertains **ONLY** to the OneShot track. In the OneShot track, at most one instantiation of each team’s agent will run in each simulation, together with an unknown mix of agents prepared by other participants and agents prepared by the organizing committee.

**How to Win** An agent’s performance will be measured by its score. An agent’s score will be the median of the profits accrued by all the factories it is assigned to manage across of all simulations.

The track will be conducted in two rounds, a qualifying round and a final round. All entrants that are not judged to break any of the SCML and ANAC submission rules will be entered into the qualifying rounds. Top-scoring agents in the qualifying round will then be entered in the final round.

The final results will be announced at IJCAI 2021. It is expected that finalists will send a representative to the ANAC workshop at IJCAI 2021, where they will be given the opportunity to give a brief presentation describing their agent.

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<sup>3</sup>Contracts are executed in order starting from the raw material to the final product and production is run in the same order which guarantees the accuracy of the utility functions