Proposal for SCM League

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Proposal for SCM League

R&D on AI in NEC

Recognition, Prediction, Control -> Negotiation

SCM League

• Concept
• Regulation
• Platform
• Schedule
Three Waves of NEC’s AI Business

NEC has a technology portfolio and business track record that extends over half a century, including AI technologies that rank top around the world.

1960

OCR
Postal address sorter

1st Wave Recognition

Fingerprint Identification
Deployed by police worldwide No.1 2004 to 2015

Face Recognition
Used in immigration control, etc. No.1 2009, 2010 2013, 2017

2000

SVM
Deep Learning
Human resource matching, etc. (RAPID Machine Learning)

Heterogeneous Mixture learning
Demand forecasting, etc.

2nd Wave Prediction

2010

Autonomous and Adaptive Control

Predictive Robust Optimization Framework

NEC the WISE
AI technologies from NEC for enriching human intellect and creativity

3rd Wave Control

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Orchestrating a brighter world

NEC
Deployment of AI to Social Solution Businesses

**Public Safety**
- **Urban Surveillance**
  - Detect potential dangers for crime prevention & solution
  - Reduced vehicle theft by 80%
- **Crowd Behavior Analysis**
- **Critical Facility Management**
- **Citizen ID / Border Control**
- **Cyber Security**

**Infrastructure/Plant**
- **Water Demand Prediction**
- **Landslide Prediction**
- **Power Plant Failure Detection**
- **Plant Failure Detection**
- **Power Demand Prediction**

**Operation Innovation**
- **Fresh Food Demand Prediction**
- **Image/weight inspection**
- **Object Recognition for traceability**
- **Quality & performance prediction**
- **Repair parts demand prediction**

**Knowledge work**
- **Voice of customer analysis**
- **VIP detection**
- **Price optimization for sale**
- **Compliance Enhancement**
- **Human resource matching**

**Urban Surveillance**
- Detect potential dangers for crime prevention & solution
- Reduced vehicle theft by 80%

**Fresh Food Demand Prediction**
- Predict demand & order products considering factors
- Reduced disposal by 80%

**Voice of customer analysis**
- Support accurate answering by understanding inquiry
- Reduced working hour by 80%
Three Waves of NEC’s AI Business

What is the NEXT WAVE?

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NEC’s Activities on Automated Negotiation

National Projects (2017～)
Drawn Traffic Control & Supply Chain Management

NEC-AIST AI Cooperative Research Laboratory (2017～)
Efficient matching of Win-Win relationships in mass customization economy

Negotiation AI

Negotiation about Product X

Grade A, $34, Feb 6th?
No. Grade A, $38, Feb 9th?
No. Grade B, $33, Feb 7th?
OK. Acceptable.

Negotiation about Shipment of it

$2, Feb 7th?
No. $2, Feb 11th?
No. $4, Feb 9th?
OK. Acceptable.

Negotiation PF

ID
Log
Ontology
Registry

Sell-Side

Need outsourcing Process Y

Need outsourcing rapid wrapping

Buy-Side

Final decision?

Negotiation AI

Good at X

Vacant truck

This condition is low risk and middle return. Final decision?

This condition is middle risk & high return. Final decision?

Need a Product X < $40, < Feb 10th

OK. Acceptable.

Negotiation AI

$2, Feb 7th?
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SCM League

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SCM League

Agents of manufacturing company buy and manufacture and sell among them.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Agent</th>
<th>Earned money</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td><img src="image" alt="Agent 2" /></td>
<td><img src="image" alt="Earned money" /></td>
</tr>
<tr>
<td>3</td>
<td><img src="image" alt="Agent 3" /></td>
<td><img src="image" alt="Earned money" /></td>
</tr>
<tr>
<td>4</td>
<td><img src="image" alt="Agent 4" /></td>
<td><img src="image" alt="Earned money" /></td>
</tr>
</tbody>
</table>

Manufacturing process

Input -> Storage space -> Product line -> Output

Money, time, material, product, factory, schedule, negotiate, money

Rank Agent Earned money

2

3

4
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Three types of agents

1) Manufacturing company (participant)
   • has a factory (with L manufacturing lines and a storage place) and a wallet,
   • can buy products from other agents through negotiation and put them in his storage place,
   • can transform products in his storage place into other products using his factory with some cost of money and time under the limited capacity of the lines,
   • can sell products in his storage place to other agents through negotiation.

2) Raw material seller (prepared by the organizing committee)
   • sells some types of products with a certain condition, namely non-negotiable.
   • The condition is fixed (or stochastically set in the future league).

3) Final product consumer (prepared by the organizing committee)
   • buys some types of products with a certain condition, namely non-negotiable.
   • The condition is fixed (or stochastically set in the future league).
Bilateral, Closed, Parallel Negotiations

Player 1

Issue
Product type,
Quantity,
Price,
Delivery time

Player 2

Issue
Product type,
Quantity,
Price,
Delivery time

Player N

Raw material
seller

Organizing Committee

Final consumer

control

control

negotiation
(closed)

negotiation
(closed)
A factory has manufacturing lines and a storage place. A line can execute several types of manufacturing process. One process occupies one line in the factory during execution. To switch the process type, overhead cost and overhead time is consumed.

The line executes manufacturing processes according to the schedule specified by the agent (participant). The scheduled process starts only if the required input is available in the storage place and money in the wallet at the start time, and they are decreased at the start time. At the end time, the output is stored in the storage place.
### Profile of Factory

<table>
<thead>
<tr>
<th>Factory Type</th>
<th>Process</th>
<th>Input</th>
<th>Lead Time</th>
<th>Cost</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Has 2 lines</strong></td>
<td>1</td>
<td>A, B</td>
<td>10</td>
<td>100</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>C</td>
<td>500</td>
<td>2000</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>F</td>
<td>3000</td>
<td>5000</td>
<td>H</td>
</tr>
<tr>
<td><strong>Has 3 lines</strong></td>
<td>1</td>
<td>A</td>
<td>300</td>
<td>800</td>
<td>B, D</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>C, B</td>
<td>80</td>
<td>350</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>C</td>
<td>45</td>
<td>75</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>C</td>
<td>150</td>
<td>200</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>G</td>
<td>800</td>
<td>4000</td>
<td>H</td>
</tr>
<tr>
<td><strong>Has 1 line</strong></td>
<td>1</td>
<td>B</td>
<td>4000</td>
<td>800</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>D</td>
<td>200</td>
<td>2000</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>E, F</td>
<td>80</td>
<td>100</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>D, G</td>
<td>60</td>
<td>300</td>
<td>H</td>
</tr>
</tbody>
</table>

A,B: Raw Material  
G,H: Final Consumer Product
Best position in Ecosystem

Raw material seller

Final consumer
Contact Fulfillment

At the contracted delivery time:
• the contracted product in the storage place of the seller-agent is moved to the storage place of the buyer-agent
• the contracted amount of money (the price) in the wallet of the buyer-agent is moved to the wallet of the seller-agent.

“Breach” occurs:
• If the quantity of the product in the storage place did not reach the contract,
• Or if the amount of money in the wallet did not reach the contract.
Then, the settlement (movement of product and/or money to the possible extent) is executed, and the agent is listed and disclosed.
Support systems: Bulletin Board

Open bulletin board is operated for finding counterparts of negotiations.

Agent can post offers specifying negotiable issue(s). Or, withdraw its own postings.

Raw material seller & Final Consumer are always offering fixed condition.

<table>
<thead>
<tr>
<th>Agent</th>
<th>Type</th>
<th>Quantity</th>
<th>Price</th>
<th>Delivery Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>sell</td>
<td>C</td>
<td>x 2</td>
<td>Nego.</td>
<td>800</td>
</tr>
<tr>
<td>buy</td>
<td>C</td>
<td>x 3</td>
<td>80</td>
<td>Nego.</td>
</tr>
<tr>
<td>buy</td>
<td>D</td>
<td>Ne.</td>
<td>Nego.</td>
<td>15</td>
</tr>
<tr>
<td>buy</td>
<td>F</td>
<td>Ne.</td>
<td>3000</td>
<td>Nego.</td>
</tr>
<tr>
<td>sell</td>
<td>G</td>
<td>x 6</td>
<td>Nego.</td>
<td>Nego.</td>
</tr>
<tr>
<td>sell</td>
<td>A</td>
<td>Ne.</td>
<td>100</td>
<td>Now</td>
</tr>
<tr>
<td>buy</td>
<td>G</td>
<td>Ne.</td>
<td>10000</td>
<td>Now</td>
</tr>
<tr>
<td>buy</td>
<td>H</td>
<td>Ne.</td>
<td>15000</td>
<td>Now</td>
</tr>
</tbody>
</table>
Support systems: Naïve Scheduler

Current schedule:
- L1: P₁, P₁, P₁
- L2: P₁
- L3: P₂, P₂

(hypothetical) Contracts

Expected level:

Factory Profile

Schedule:
- Current schedule: P₁, P₁, P₁

Scheduling target:
- P₁, P₂

Generated schedule:
- L1: P₁, P₁, P₁, P₁
- L2: P₁, OH, P₂
- L3: P₂, P₂
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  • Schedule
Design Philosophy of the Platform

- Platform not only for Research
- Extendable by Researchers
- Ease of Use
Platform not only for Research

- Wrapping real IT system with Utility function
- Keeping the same interface

Utility function

Current PF

file

Utility Function Wrapper

Next PF

Real IT System
- ERP: Enterprise Resource Planning
- WMS: Warehouse Management System
- LMS: Logistics Management System

Future
Extendable by Researchers

- Mechanism, Agent, and Utility Function are all plugins so that any researcher can develop own one.

Capability of agents

- Propose() Accept()
- Propose() Accept()
- Accept()

Required Capabilities

- Propose() Accept() (Bi-lateral)
- Propose() Accept() (Bi-lateral mediated)
- Accept() (double auction)

mediator
Ease of Use

Cloud-based
- Jupyter development interface
c.f. “Jupiter” (, 2018)
- Runnable on the cloud

Programming Language Independency
- SwaggerAPI (= OpenAPI)
Base Platform

Conceptual Features

- Situated negotiations
  - Negotiations run within a world
- Simultaneous interdependent negotiations
  - Via utility functions
- World driven dynamic utility functions
  - Based on optimization, scheduling, etc
- Supports meta-negotiation
  - Agreeing on protocol/protocol parameters
- Supports mediated and unmediated protocols

Implementation Features

- Distributed and secure via a standard-respecting web API
- Language neutral (with special client libraries for Java and Python)
- Extendible (protocols, agents, ufuns, ufun operators, etc are easily added)
- Simple API
Relation between Entities within a single World

World

Whiteboard

Session

Proposal Response

Agent

Meta-Negotiator

Role

Negotiator

Meta-Negotiator

Role

UFun

Utility Function

Agent

Meta-Negotiator

Role

Negotiator

Meta-Negotiator

Role

UFun

Utility Function

World Manager

Storage

Name Resolver

Platform
Worlds, Platform and Clients

Platform

Tournament

Worlds, Platform and Clients

Authorization

Storage

Name Resolver

Client

Utility Function

Authentication

Client

Utility Function

Client

Utility Function

Client

Mechanism
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• Schedule to be discussed