

Automated Negotiation AI Breaking the limit of individual optimization

-- Coordinating economic entities

while preserving confidentiality and sovereignty --

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NEC brings together and integrates technology and expertise to create the ICT-enabled society of tomorrow.

We collaborate closely with partners and customers around the world, orchestrating each project to ensure all its parts are fine-tuned to local needs.

Every day, our innovative solutions for society contribute to greater safety, security, efficiency and equality, and enable people to live brighter lives.

Automated Negotiation among Smart Systems

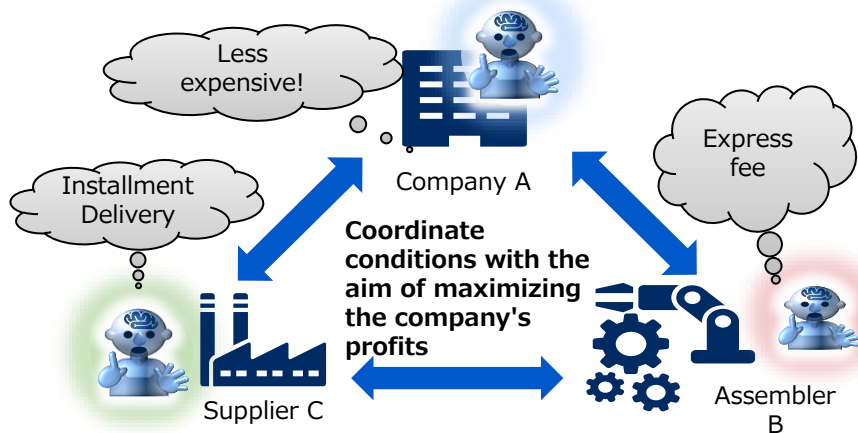
Coordination of behavior and interest among smart systems will be super important.

→ Breaking the limits of individual and internal optimization

Centralized/Cooperative optimization/control has problems in confidentiality and sovereignty.

→ **Negotiation-based mechanisms for coordination among economic entities**

Coordination of trading conditions among companies



Discover/optimize reciprocity

Coordination of path plans among moving objects



Smoothly achieve each objective

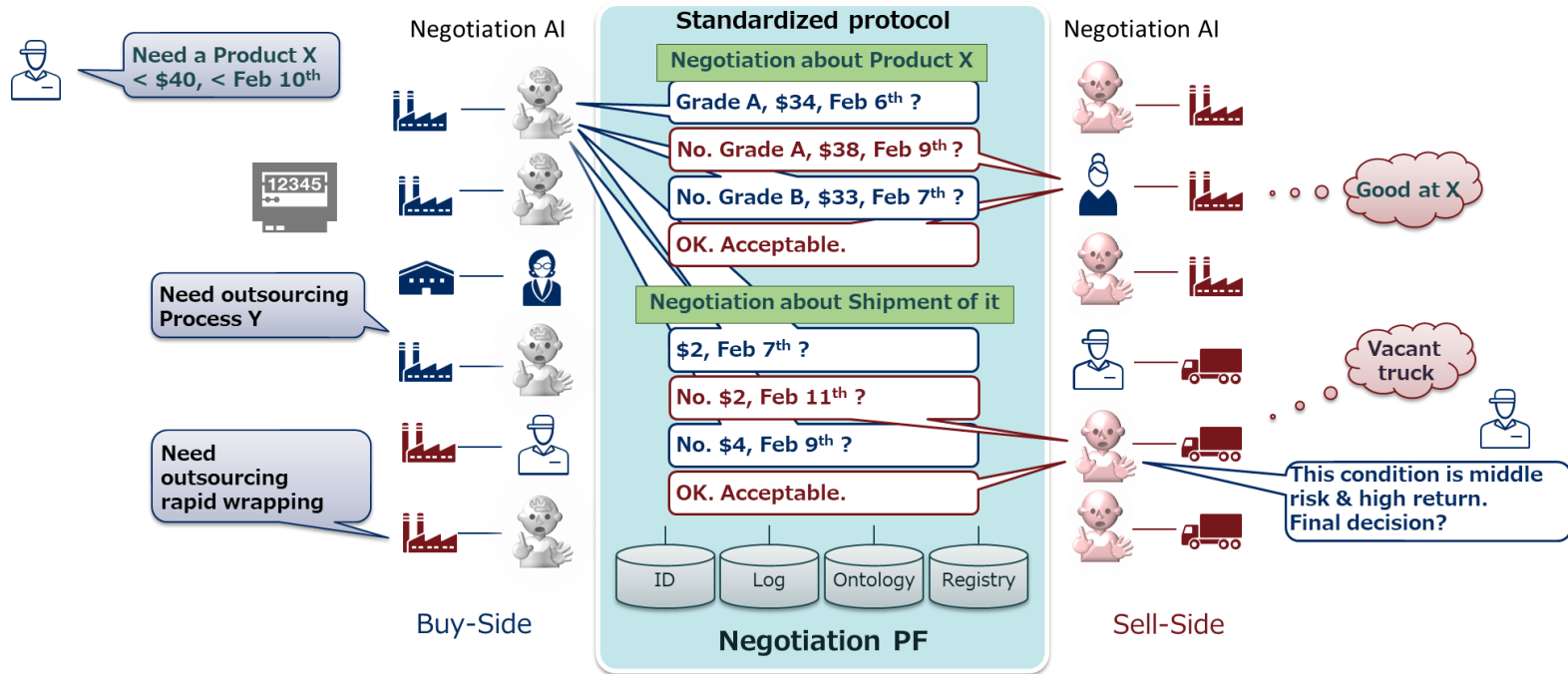
Negotiation of trading conditions among companies

Consult with counterparty on behalf of your company

- Conclude business negotiations on the best possible terms
- Refuse those that are not acceptable.

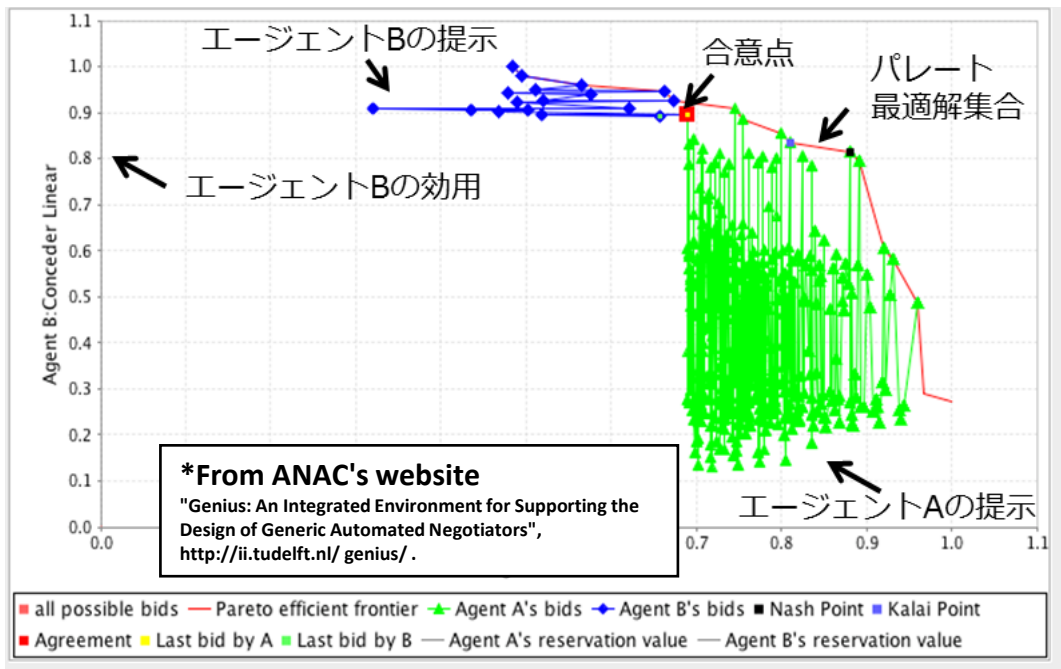
Both

- AI vs. Human
- AI vs. AI

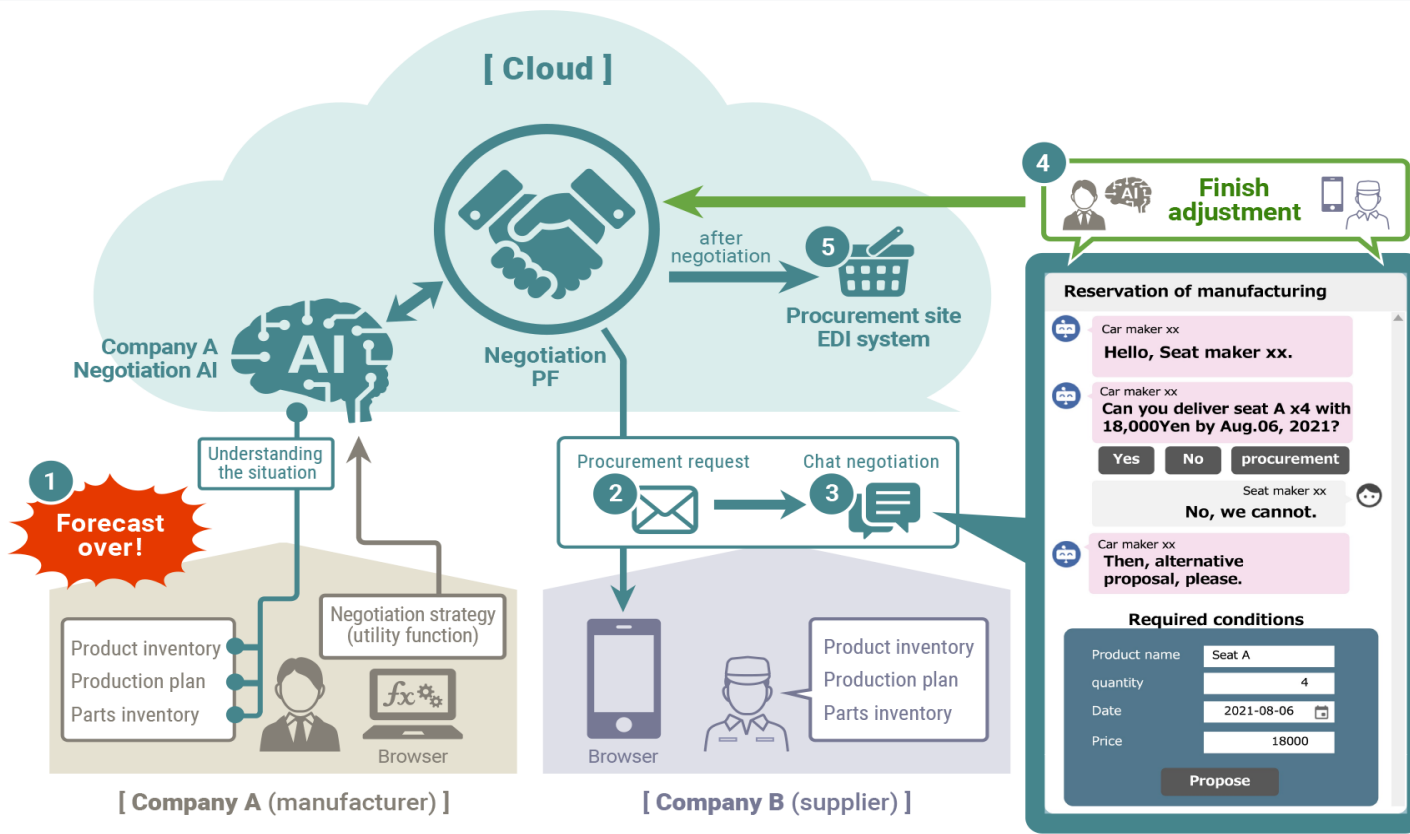


Bargaining agents to maximize self-interest (utility function)

- Automatic generation of agreement terms to propose to the other party
- Automatic decision on acceptance/rejection of proposed agreement terms
- Automatic decision on whether the negotiation session should be terminated here



Automated Negotiation against human

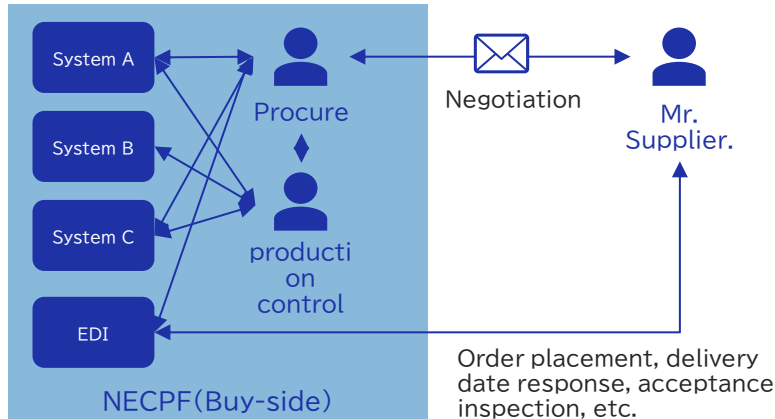


- Image of applying automated negotiation for parts procurement as an example -

Use-Test in a NEC's group company

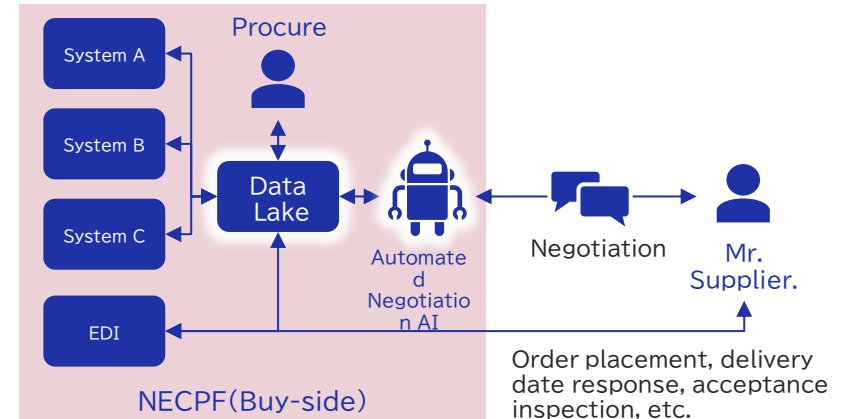
Before

- To avoid shortages due to late delivery from suppliers, the procurement manager coordinates with suppliers via e-mail and phone calls after checking with multiple internal systems and production control departments
- Waiting time on both the purchasing and sales side for internal checks



After

- Aggregate information necessary to adjust delivery dates into a data lake and adjust delivery dates to suppliers via AI chatbot.
- Immediate confirmation of and response to supplier proposals, reducing the time required to adjust delivery dates.



Results

- ◆ Automatic agreement rate **95%**
- ◆ **73% of** negotiations were completed within **5 minutes**.

Verification details		Before (without negotiation AI)		After (using negotiation AI)	
		Time from negotiation request to completion of negotiations※1	Auto agreement rate	Time from start to completion of negotiations※2	Auto agreement rate
Adjustment for delayed delivery responses	Peripheral components	3 hours - 2 days	0	33 sec.	100% (3/3)
	electronic equipment	3 hours - 2 days	0	4 minutes 49 seconds	85.71% (18/21)
Coordination of requests to accelerate delivery dates	Peripheral components	3 hours - 2 days	0	1 minute 53 seconds	80.95% (17/21)
	electronic equipment	3 hours - 2 days	0	38 sec.	100% (95/95)
whole		3 hours - 2 days	0	1 minute 17 seconds	95% (133/140)

(the number of successful automated negotiations/total number of negotiations)

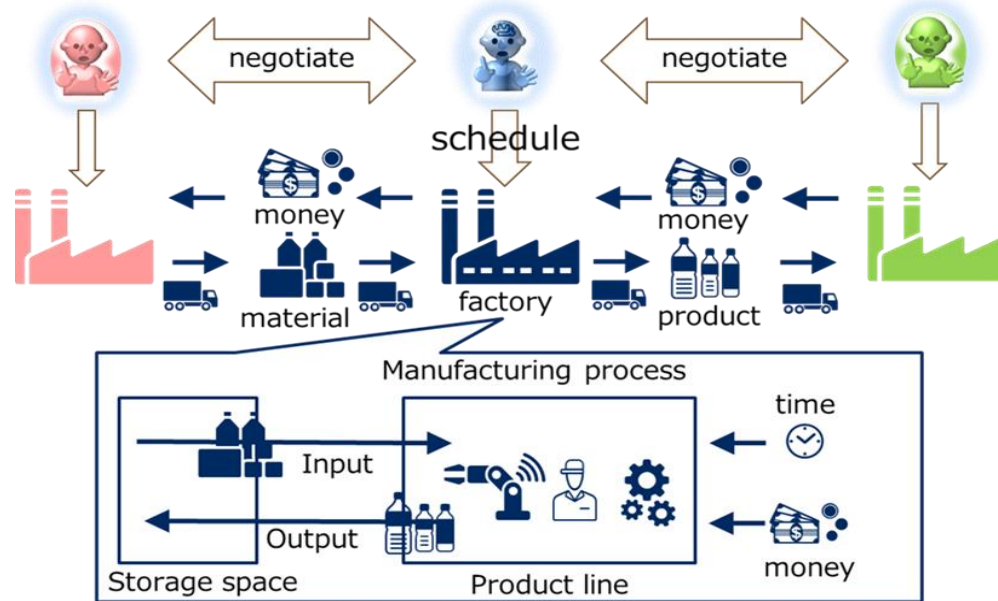
Negotiating skill makes all the difference in the profits earned.

Annual SCM League, an international competition for negotiation skills, starting in 2019.

Contestants submit manufacturer negotiation AIs. In the virtual economic space, the AIs negotiate with each other to buy and sell parts/products,

The winner is the AI that earns the largest profit after a certain period of time.

Participating from 8 teams in 2019 to 72 teams in 2024.



Rank	Agent	Earned money
1		
2		
3		
4		

In one year, the winning team had a profit margin of more than 1,000 times the second-place team!

Technology Trends to Make Negotiation AI Smarter

The following technology trends can be read from the conferences and competitions

Rule-based

People think and program "what to do in what situation."

Utility space search

Numerically search for proposals that increase self-utility (and estimated opponent utility)

Supervised learning

Data on the response history of good (human) negotiators and use machine learning techniques to mimic their behavior.

Reinforcement Learning

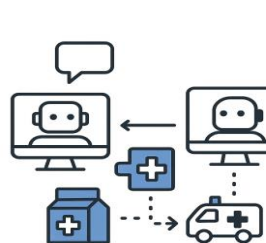
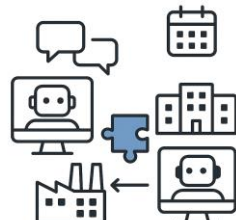
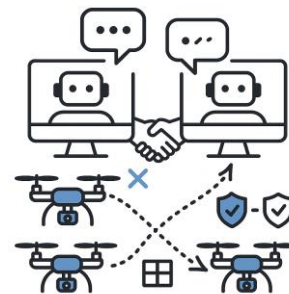
Automatic trial-and-error on the simulator in advance to develop "what to do in what situation".

This is perfectly in line with the history of the evolution of autoplay technology in chess and poker!

Other Applications

Negotiation of terms and conditions for

- Arrangement of route/flight plans of AGVs/drones
 - Arrangement/provision of logistics services
 - Trading of financial products
 - Allocation of shared facilities
 - Arrangement/provision of medical resources
 - Smart city management spanning multiple economic entities
 - Construction site management spanning multiple contractors
- etc.



Applications related to HPC?

Negotiation of terms and conditions for

- Computing resource provision/consumption
- Data provision/sharing/acquisition/generation/use
- Data analysis/machine learning outsourcing
- Federated learning cooperation
- Simulation/physical experiment outsourcing
- Sale/rental/service of trained models/AI agents

Anything else?

Or, opposite direction? -> HPC for AN

- Evaluation of the utility function
- Optimization of offer generation

Invitation to Automated Negotiation SCM Consortium

- Problem definition and target use case examination
- Development of solution architectures and technologies to solve problems
- PoC for the social implementation
- International standardization, policy proposal
- Networking among members
(study group meeting, presentation meeting, and consultation meeting,,)

Automated Negotiation demonstrations



Automated negotiation of parts procurement

You can see a demonstration of automated negotiations by AI referring to the adjustment of the price, delivery date, and quantity of automotive parts in the automotive supply chain.



Automated negotiation of logistics arrangements

You can see a demonstration of negotiations between AI and people, referring to the adjustment of airlift quotas and people, referring to the adjustment of airlift quotas among shippers, logistics companies and airlift companies in air logistics.



Category	Organization Name	Promoter	Belonging Work Group		
			Manufacturing	Logistics	Common
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	Ok! Electronic Industry CO.,Ltd	●		●	●
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	ITOCHU Techno-Solutions Corporation				●
	NEC Solution Innovators, Ltd.		●	●	●
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	Intent Exchange, Inc.		●	●	●
	AIST Solutions Company		●	●	●
	NEC Business Intelligence, Ltd.		●	●	●
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VAID Corporation		●			
JAPAN INDUSTRIAL LOCATION CENTER			●	●	
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MITSUBISHI HEAVY INDUSTRIES, LTD.			●	●	
NEC Platforms, Ltd.			●	●	

<https://automated-negotiation.org/>

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