

くずし字を読む エッジ A I の開発

Development of Edge AI System
for *Kuzushiji* Recognition



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Introduction

Project to build an international collaborative research network for pre-modern Japanese texts (NIJL-NW project)

was inaugurated at the National Institute of Japanese Literature in 2014, and it was decided to convert approximately 300 thousand “Pre-modern Japanese Books” into image data to be amalgamated with the bibliographic data base to produce “Database of Pre-modern Japanese Books”.



Too many books to interpret!
Please develop the **ICT system** to help us!

Japanese literature researchers

Problem formulation

Discrimination of *Kuzushiji* images to character types represented by Unicode.



(ex) Classifying “の”
in spite of different original *Kanji* characters.



Neural network approach (since 2015)

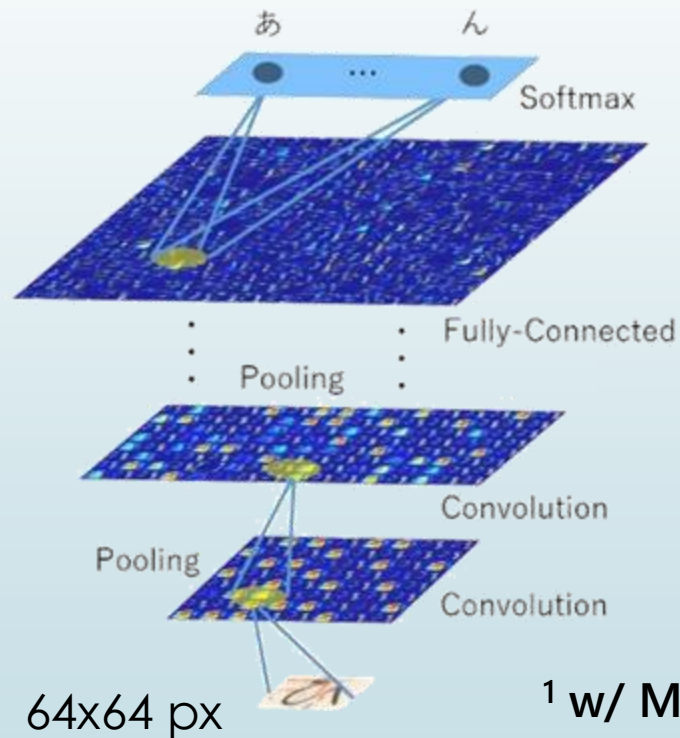


Why neural network approach?

- It may be possible to learn the difference in the characteristics of *Kuzushiji* (hand-written/prints, genres, regions, periods, etc).
 - no need to prepare a large database.
- Once the model is built, the time required for inference (recognition) is very short.
 - It can be realized as the application software operated even on small computers.

Network architecture

18-Layered Convolutional Neural Network (CNN)



Layer Type	#Units
Fully-Connected	65535
Fully-Connected ²	1024
Fully-Connected ^{2,3}	1024
Convolution ^{1,2}	512
Convolution ^{1,2}	256
Convolution ^{1,2}	128
Convolution ^{1,2}	64

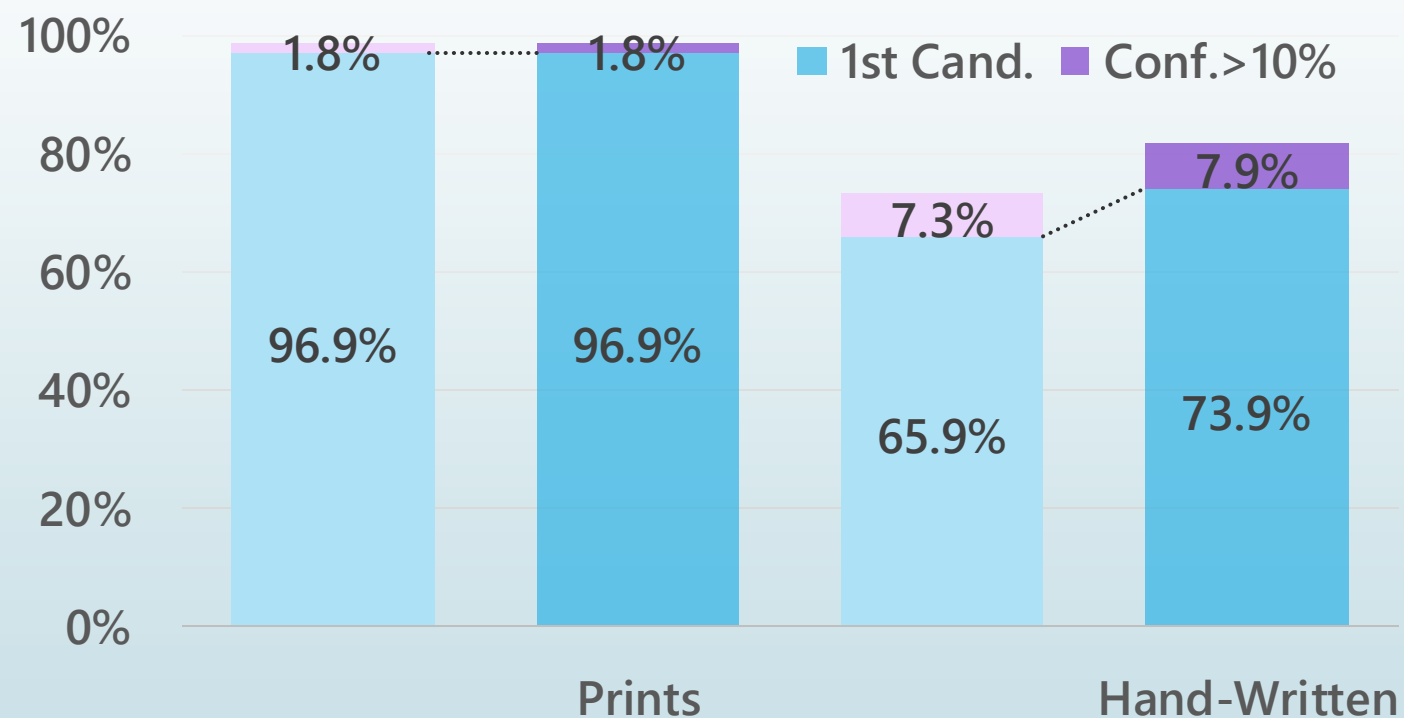
¹ w/ MaxPooling ² w/ ReLU ³ w/ Dropout

Datasets for Learning

	WWW Download		Manual Extraction			Total	#char type	Total/ #char
	CODH Data	和翰名苑	ADEAC Data	CODH Data	五體字類			
Kana	714,568	3,265	9,061	9,511	1,473	737,878	77	9,583
	(96.82%)	(0.44%)	(1.23%)	(1.29%)	(0.20%)			
Kanji, Others	360,550	—	17,068	2,207	—	379,825	4,258	89
	(94.96%)		(4.49%)	(0.58%)				
Total	1,075,118	3,265	26,129	11,718	1,473	1,117,703	4,335	258
	(96.19%)	(0.29%)	(2.34%)	(1.05%)	(0.13%)			
#char type	4,299	48	1,638	417	48			

Recognition Results

compared with learning by CODH data only



WWW Application

(<http://vpac.toyota-ct.ac.jp>)

When loading a document image and select one character by a mouse or a finger, the recognition result is output **immediately**.

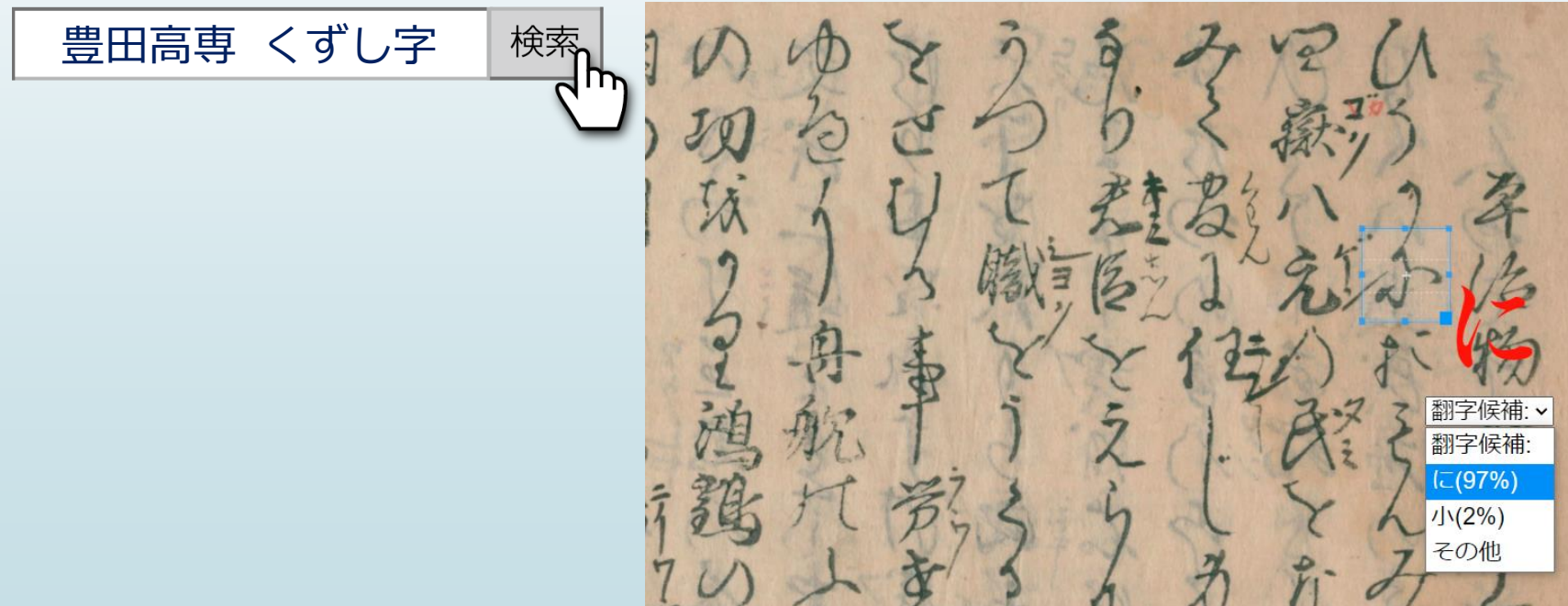


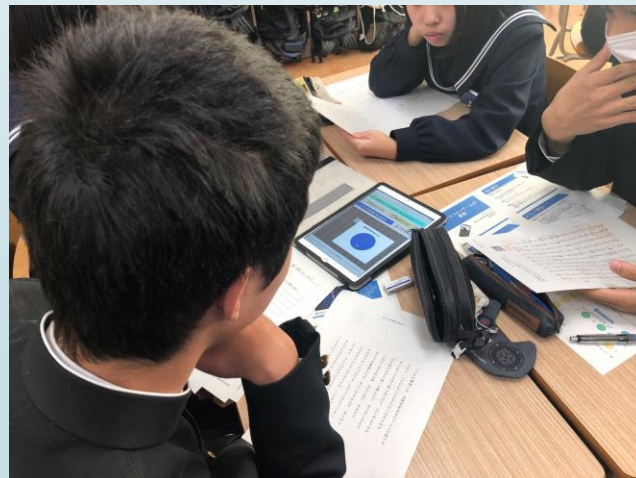


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Development of standalone system for recognition of *Kuzushiji*

- At present, there are not many schools and community facilities that have the internet environment such as Wi-Fi that can be used by a large number of people.
- We have been developing **the standalone (edge AI) system by small computers** for extracting and recognizing *Kuzushiji*.



“Kuzushiji recognizer” by cheap and small AI camera



Possible to recognize *Hentaigana* only.
(Recognition rate $\simeq$ 75%)

“*Kuzushiji* recognizer” by Raspberry Pi

System that automatically extracts and recognizes *Kuzushiji* from pre-modern Japanese book images using **Raspberry Pi**, small and inexpensive single-board computers.



In the captured image, character areas can be detected in about **5 seconds**. The network can recognize a *Kuzushiji* character in about **0.08 seconds**.

Evaluation(#Char.=939)

Results of extracting

- Precision 92.6%
- Recall 87.4%
- F-measure 89.9%
(#Output Char.=887,
#Accurate Char.=821)

Results of recognition

- Precision 76.3%
- Recall 72.1%
- F-measure 74.2%
(#Accurate Char.=677)

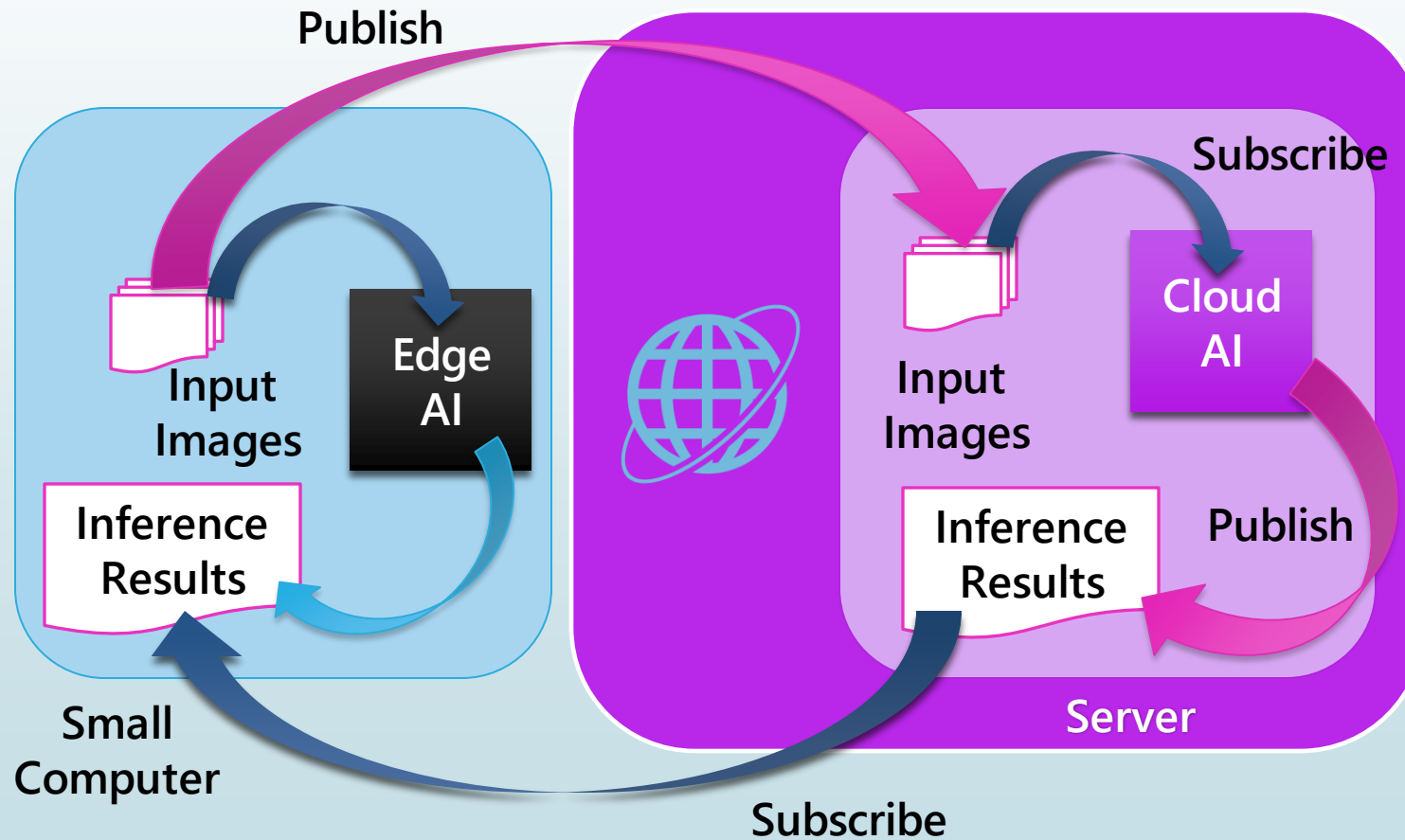
(Top 5 in certainty)



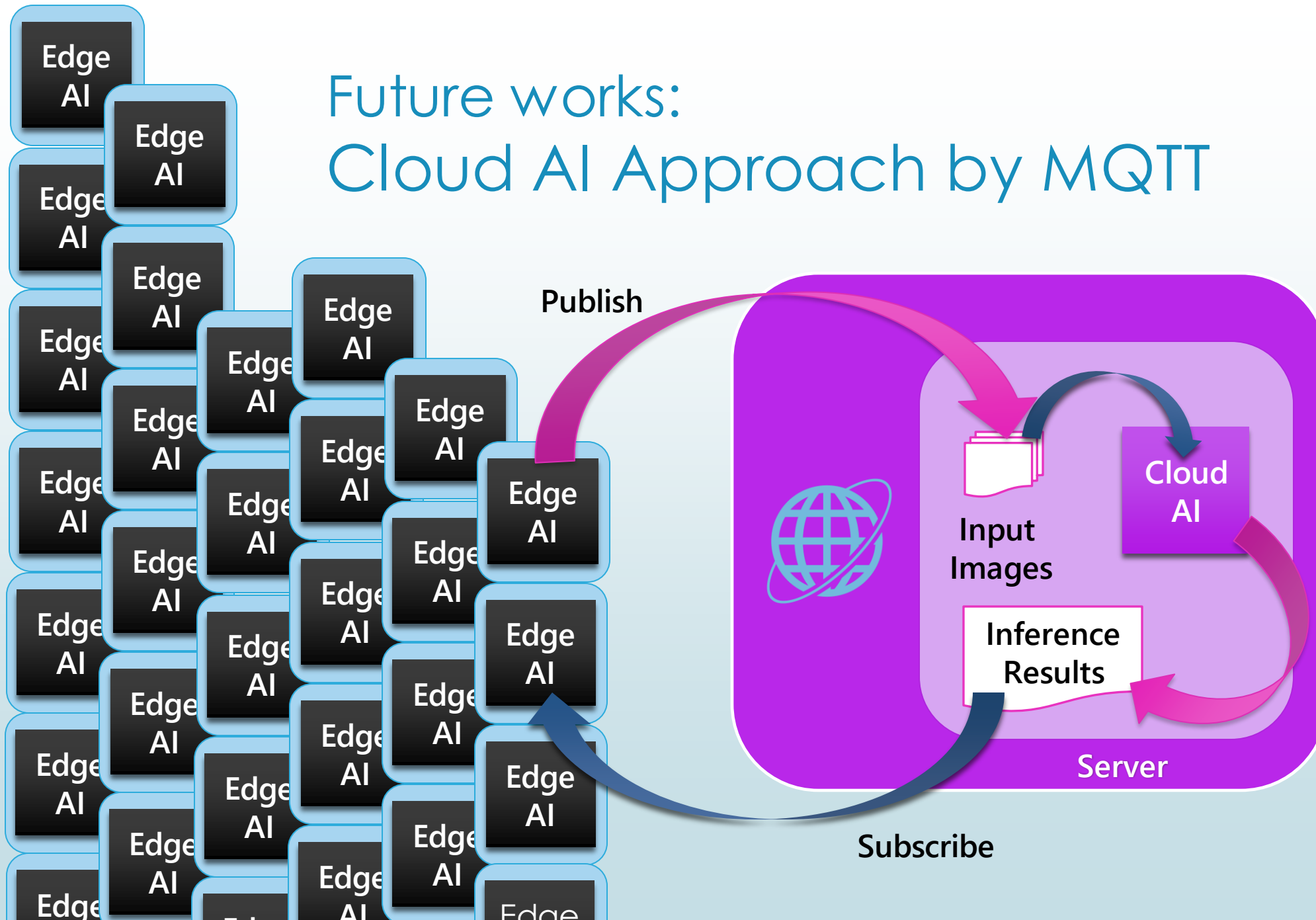
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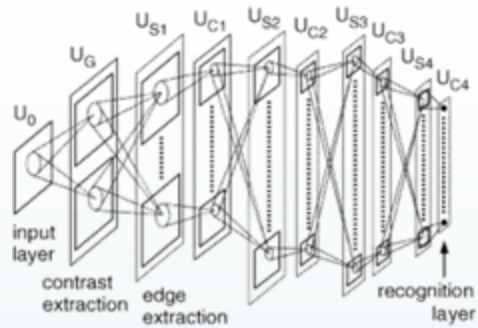
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Future works: Cloud AI Approach by MQTT



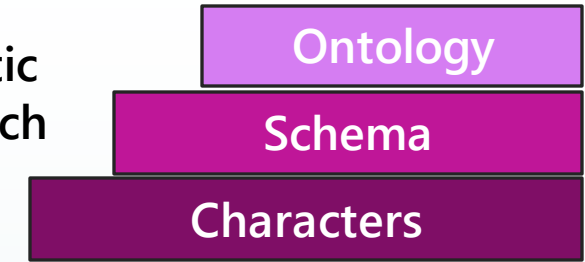
Future works: Cloud AI Approach by MQTT





Neocognitron (Fukushima 1979)
can recognize *Kuzushiji*
(Hayasaka, et al. 2015).

Semantic
Approach



1st AI Boom

Perceptron
(1950s-70s)

Possible to solve
simple problems.

2nd AI Boom

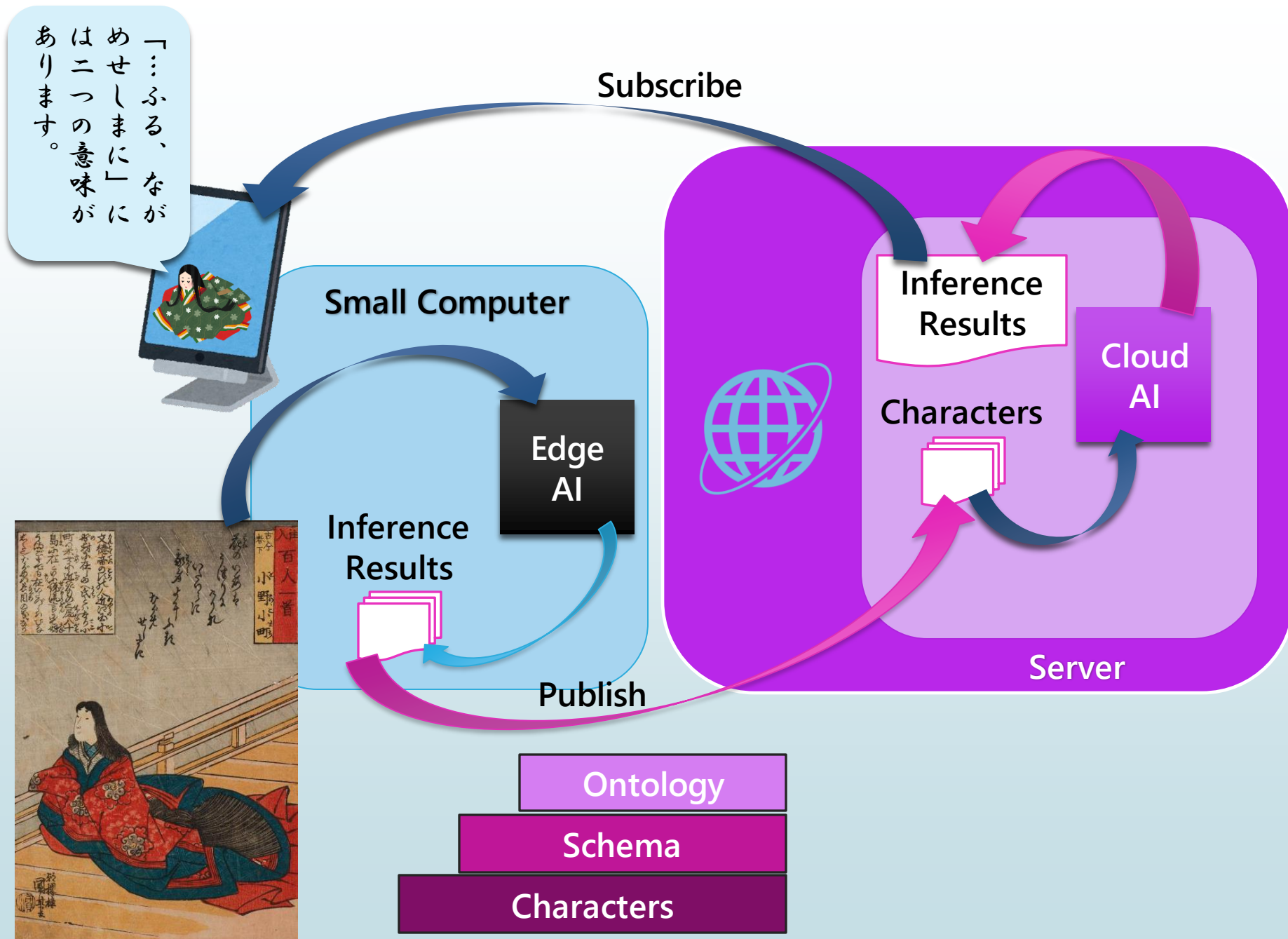
**Multi-
Layered
Perceptron**
(1980s-90s)

Possible to solve
annoying problems.

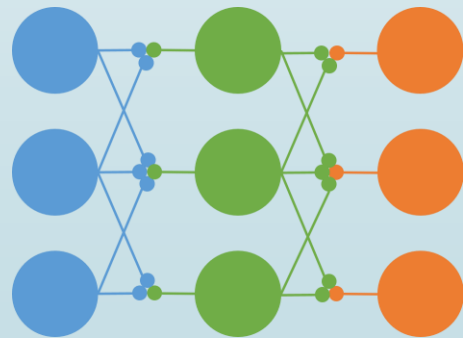
3rd AI Boom

**Deep
Learning**
(2010s-)

Possible to solve
problems **we cannot
think of answers** (at
super high speed).



Thank you for your attention.



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