How to make problem cards
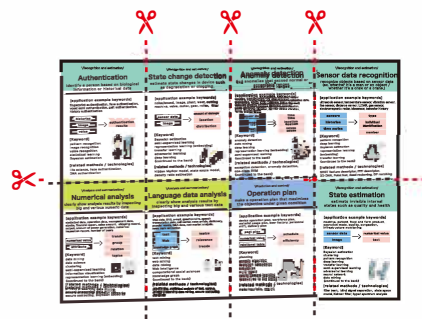
\STEP1/

Make a double-sided print on a A4 sheet in landscape.
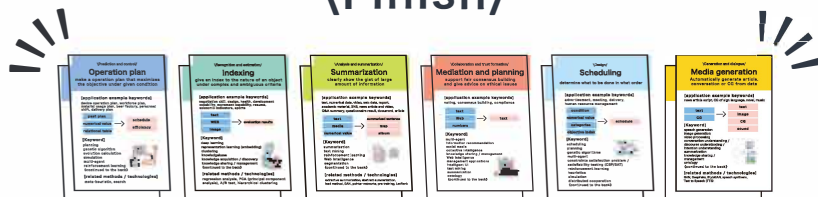
front   back
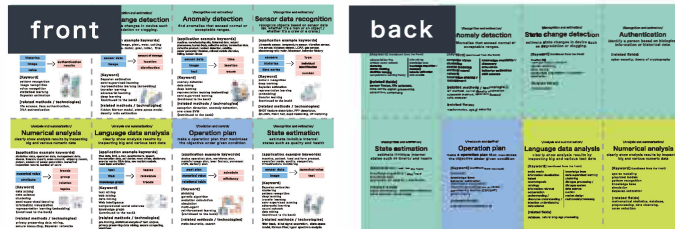
\STEP2/

Cut along dotted lines.

\Finish/

\Prediction and control/

Numerical prediction

predict numerical values in the near future

[application example keywords]

energy consumption, prices, train delays, hospital waiting times, traffic jam forecasts, electricity demand forecasts, weather forecasts

numerical value	
text	→ predicted value

[Keyword]
statistical learning
deep learning
neural network
sparse modeling
knowledge acquisition / discovery
simulation
market design
multi-agent
《continued to the back》

[related methods / technologies]
regression analysis, RNN, LSTM, Kalman filter, state space model, statistical time series model (ARIMA / SARIMA), data assimilation

---

\Prediction and control/

Probability prediction

predict the probability of the near future event

[application example keywords]

market size, delivery probability, congestion rate, behavior model, weather forecast

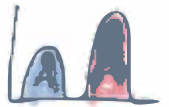| numerical value	
text	→ probability

[Keyword]
statistical learning
state space model
graphical model
deep learning
neural network
sparse modeling
knowledge acquisition / discovery
simulation
《continued to the back》

[related methods / technologies]
Bayesian network, data assimilation

\Prediction and control/

Predicted candidate presentation

present diverse possibilities in the future

[application example keywords]

typhoon outbreak location, new services / markets, regional economy, location of failure
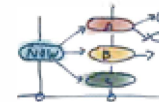
numerical value	candidates
text	scenario

[Keyword]
Bayesian estimation
semi-supervised learning
neural network
knowledge acquisition / discovery
auction
market design
Web intelligence
behavior estimation
《continued to the back》

[related methods / technologies]
simulation, scenario planning

\Prediction and control/

Operation and control

move devices automatically according to the purpose

[application example keywords]

automobile, heavy machinery, airplane, machinetool, agricultural machinery, ship, traffic light, plant, forklift

Image	
sensor	→ control value
manual input	

[Keyword]
simulation
multi-agent
reinforcement learning
deep learning
semi-supervised learning
neural network
《continued to the back》

[related methods / technologies]
cloud robotics, probabilistic robotics

Probability prediction

predict the probability
of the near future event

[Keyword] (continued from the front)

market design
multi-agent
Bayesian estimation
decision making / consensus building
fuzzy logic

[related fields]

earth science, meteorology,
control engineering

Numerical prediction

predict numerical values
in the near future

[Keyword] (continued from the front)

Bayesian estimation
decision making / consensus building
fuzzy logic

[related fields]

earth science, meteorology,
control engineering

Operation and control

move devices automatically
according to the purpose

[Keyword] (continued from the front)

HRI
behavior estimation
swarm intelligence
distributed coordination
symbol emergence
in robotics
intelligent mechatronics
intelligent robots
intelligent robotics
cognitive robotics

embodiment
subsumption architecture
constraints satisfaction
problem / satisfiability
testing (CSP/SAT)
planning
fuzzy logic
ontology

[related fields]

control engineering robotics

Predicted candidate presentation

present diverse possibilities in the future

[Keyword] (continued from the front)

multi-agent
decision making / consensus building
graphical model

[related fields]
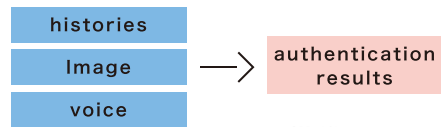
earth science, meteorology

\Recognition and estimation/

Authentication

identify a person based on biological
information or historical data

[application example keywords]

fingerprint authentication, face authentication,
vocal cord authentication, gait authentication,
history authentication

histories		
Image	→	authentication results
voice		

[Keyword]

pattern recognition
Image recognition
voice recognition
statistical learning
Bayesian estimation

[related methods / technologies]

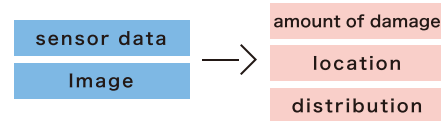life science, face authentication,
DNA authentication

\Recognition and estimation/

State change detection

estimate state changes in device such
as degradation or clogging.

[application example keywords]

noise/sound, image, plant, wear, cutting
machine, valve, motor, gear, roller, filter

sensor data		amount of damage
Image	→	location
		distribution

[Keyword]

Bayesian estimation
semi-supervised learning
representation learning (embedding)
transfer learning
adversarial learning
deep learning
《continued to the back》

[related methods / technologies]

hidden Markov model, state space model,
density ratio estimation

---

\Recognition and estimation/

Anomaly detection

find anomalies that exceed normal or
acceptable ranges.

[application example keywords]

machine, manufacturing site, historical data, natural
phenomena, human body, collective action, transaction data,
defective product, incident detection, satellite,
power generator vibration, railroad vehicle vibration,
falling, sudden illness

sensor data		time
Image	→	location
text		cause
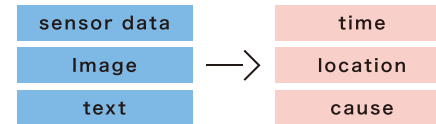
[Keyword]

anomaly detection
data mining
deep learning
representation learning (embedding)
semi-supervised learning
《continued to the back》

[related methods / technologies]

exception detection, anomaly detection,
one-class SVM
《continued to the back》

\Recognition and estimation/

Sensor data recognition

recognize objects based on sensor data
(ex. whether it's a man or an object /
whether it's a craw or a crane.)

[application example keywords]

ultrasonic sensor, temperature sensor, vibration sensor,
line sensor, distance sensor, LIDAR, gas sensor,
electromagnetic radar, biosensor, behavior history

sensors		type
histories	→	individual identification
time series		number
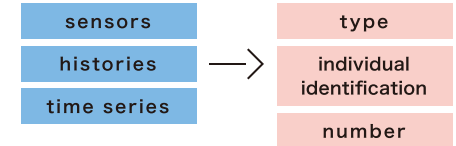
[Keyword]

pattern recognition
deep learning
Bayesian estimation
representation learning
(embedding)
transfer learning
《continued to the back》

[related methods / technologies]

SHOT feature descriptor, PPF descriptor,
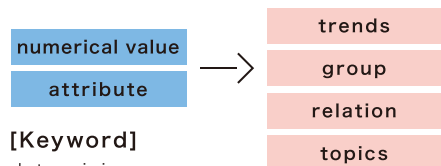3D-DNN, Point Net, dead reckoning, DP matching

---

\Analysis and summarization/

Numerical analysis

clearly show analysis results by inspecting
big and various numeric data

[application example keywords]

statistical data, operation data, management data,
stocks, financial report, sales amount, shipping record,
output, amount of power generation, numerical
inspection record, number of users

numerical value		trends
attribute	→	group
		relation
		topics

[Keyword]

data mining
data science
clustering
semi-supervised learning
information visualization
representation learning (enbedding)
《continued to the back》
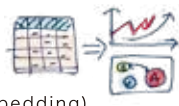
[related methods / technologies]

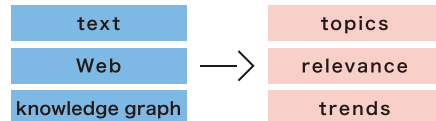privacy preserving data mining,
secure computing, Bayesian networks

\Analysis and summarization/

Language data analysis

clearly show analysis results by
inspecting big and various text data

[application example keywords]

Web data, SNS, e-mail, questionnaire, speech
transcription data, call center, news article, dictionary,
popular words, Q&A data, new market analysis,
news topic extraction

text		topics
Web	→	relevance
knowledge graph		trends

[Keyword]

text mining
web mining
data mining
Web intelligence
computational social sciences
knowledge graph
《continued to the back》
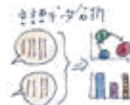
[related methods / technologies]

pre-training, statistical analysis of text, corpus,
privacy preserving data mining, secure computing,
word2vec

\Prediction and control/

Operation plan

make a operation plan that maximizes
the objective under given condition

[application example keywords]

device operation plan, workforce plan,
material usage plan, beer factory, personnel
shift, delivery plan

past plan		schedule
numerical value	→	efficiency
relational table		
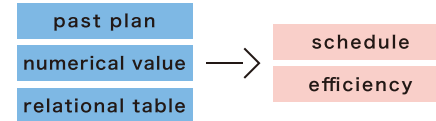
[Keyword]

planning
genetic algorithm
evolution calculation
simulation
multi-agent
reinforcement learning
《continued to the back》
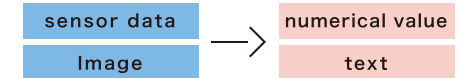
[related methods / technologies]

meta-heuristic, search

\Recognition and estimation/

State estimation

estimate invisible internal
states such as quality and health

[application example keywords]

machine, patient, food and farm product,
operation mode, quality, congestion,
infrastructure monitoring

| sensor data | | numerical value |
| Image | → | text |

[Keyword]

Bayesian estimation
clustering
pattern recognition
deep learning
transfer learning
semi-supervised learning
adversarial learning
neural network
data mining
《continued to the back》

[related methods / technologies]

filter bank, blind signal separation, state space
model, Kalman filter, hyper spectrum analysis

Sensor data recognition

recognize objects based on sensor data (ex. whether it's a man or an object / whether it's a craw or a crane.)

[Keyword] (continued from the front)

adversarial learning
artificial neural network
clustering
sparse modeling
statistical learning
computational learning theory

data mining
knowledge base
knowledge acquisition / discovery
behavior estimation
data science

[related fields]
sensor fusion, life sciences, time series signal processing, ubiquitous computing

Anomaly detection

find anomalies that exceed normal or acceptable ranges.

[Keyword] (continued from the front)

computer vision
clustering
sparse modeling
artificial neural network
knowledge sharing / management

knowledge acquisition/ discovery
simulation
behavior estimation
skill science

[related methods / technologies]
MT method, kernel density estimation, subspace method, invariant method, auto encoder

[related fields]
mechatronics, cyber security

State change detection

estimate state changes in device such as degradation or clogging.

[Keyword] (continued from the front)

clustering
artificial neural network
sparse modeling
data mining
knowledge acquisition / discovery
simulation

[related fields]
mechatronics

Authentication

identify a person based on biological information or historical data

[related fields]
cyber security, theory of cryptography

State estimation

estimate invisible internal states such as quality and health

[Keyword] (continued from the front)

knowledge acquisition / discovery
knowledge base
application for medical / healthcare

[related fields]
signal processing, statistical mechanics, earth science, meteorology

Operation plan

make a operation plan that maximizes the objective under given condition

[Keyword] (continued from the front)

heuristics
knowledge base
behavior estimation
distributed cooperation
constraints satisfaction problem / satisfiability testing (CSP/SAT)
graph theory

[related fields]
mathematical programming

Language data analysis

clearly show analysis results by inspecting big and various text data

[Keyword] (continued from the front)

social media
information visualization
kansei
onomatopoeia
ontology
information retrieval
conversation understanding / discourse understanding / intention understanding
data science

knowledge base
semi-supervised learning
clustering
dialogue processing / dialogue system
data science
auction
market design
multimodal processing

[related fields]
database, natural language processing

Numerical analysis

clearly show analysis results by inspecting big and various numeric data

[Keyword] (continued from the front)

sparse modeling
graphical models
pattern recognition
knowledge base
simulation
Bayesian estimation

[related fields]
mathematical statistics, database, preprocessing, data cleansing, noise reduction
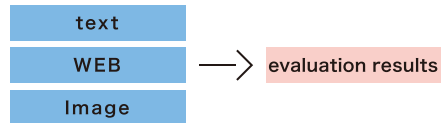
\Recognition and estimation/
Indicator creation
give an index to the nature of an object under complex and ambiguous criteria

[application example keywords]

negotiation skill, design, health, development capability, movement capability, resume, economic indicators, sports

| text |
| WEB | → evaluation results
| Image |

[Keyword]

deep learning
representation learning (embedding)
clustering
knowledgebase
knowledge acquisition / discovery
knowledge sharing / management
《continued to the back》

[related methods / technologies]

regression analysis, PCA (principal component analysis), A/B test, hierarchical clustering
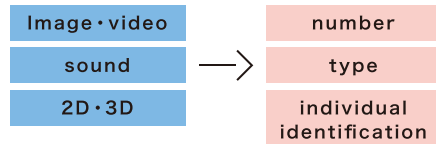

\Recognition and estimation/
State change detection
recognize objects or what's heard from image, video, or sound information

[application example keywords]

speech recognition, Image recognition, visual inspection, waste, products, people, trees, automobiles, animals, heavy machinery

Image・video		number
sound	→	type
2D・3D		individual identification

[Keyword]
computer vision
image recognition
speech recognition
generic object recognition
pattern recognition
representation learning (embedding)
semi-supervised learning
《continued to the back》

[related methods / technologies]
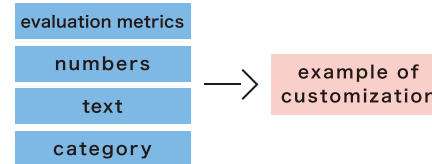phonetics, acoustic scene analysis, pre-learning

---

\Design/
Personalization
customize the displayed contents to match the users' (hidden) preferences

[application example keywords]

news articles, video distribution, dialogue, services, advertisement distribution

| evaluation metrics |
| numbers |
| text | →   example of customization
| category |

[Keyword]

information recommendation
dialogue processing / dialogue system
text mining
knowledge acquisition / discovery
kansei
《continued to the back》

[related methods / technologies]

privacy preserving calculation,
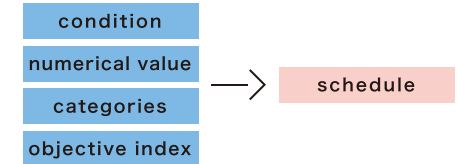privacy preserving data mining

---

\Design/
# Scheduling
determine what to be done in what order

[application example keywords]

advertisement, meeting, delivery, personnel shift

| condition |
| numerical value |
| categories | →   schedule
| objective index |

[Keyword]

scheduling
planning
genetic algorithms
multi-agent
constraints satisfaction problem / satisfiability testing (CSP/SAT)
reinforcement learning
heuristics
simulation
distributed cooperation
《continued to the back》
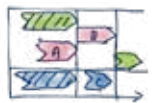
\Analysis and summarization/
Summarization
clearly show the gist of large amount of information

[application example keywords]

text, numerical data, video, web data, report, academic material, SNS, news article and video, Q&A summary, questionnaire result, document, article

text		summarized sentence
media	→	map
numerical value		diagram
	album
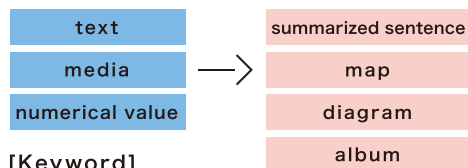
[Keyword]

summarization
text mining
reinforcement learning
Web intelligence
segmentation
《continued to the back》
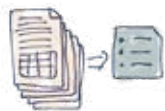
[related methods / technologies]

extractive summarization, abstract summarization, lead method, GAN, pointer networks, pre-training, LexRank
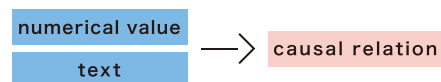

\Analysis and summarization/
Causal inference
find causal relationship based on data; predict what changes what

[application example keywords]

epidemiology, economics, chemistry, sleep disorders, sales changes, root cause of failure estimation

| numerical value |
| text | →   causal relation

[Keyword]
AI understandability
semantics
search / logic /
inference algorithm
clustering
knowledge graph

[related methods / technologies]

statistical causal analysis,
structural equation modeling, causal graph,
independent component analysis, LiNGAM

\Analysis and summarization/
Media data analysis
clearly show analysis results by inspecting big and various image / video data

[application example keywords]

image, sound, vibration, surveillance image, fixed-point camera, microscope image, manufacturing line image, sports image

Image		trends
video	→	trouble / anomaly
sound		points of caution
	group
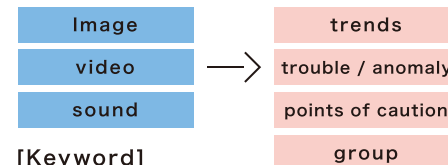
[Keyword]
computer vision
image recognition
generic object recognition
data mining
data science
information visualization
《continued to the back》

[related methods / technologies]

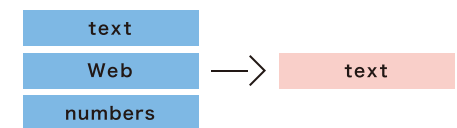privacy preserving data mining, secure computing

---

\Collaboration and trust formation/
Mediation and planning
support fair consensus building and give advice on ethical issues

[application example keywords]

voting, consensus building, compliance

| text |
| Web | →   text
| numbers |

[Keyword]

multi-agent
information recommendation
social media
collective intelligence
knowledge sharing / management
Web intelligence
management applications
intelligent UI
text mining
summarization
ontology
《continued to the back》

\Design/
Scheduling

determine what to be done in what order

[Keyword] (continued from the front)

evolutionary computation
swarm Intelligence
behavioral economics
graph theory
knowledge acquisition / discovery

\Design/
Personalization

customize the displayed contents to match the users' (hidden) preferences

[Keyword] (continued from the front)

ontology
knowledge base
knowledge graph
game theory
reinforcement learning
social media
affordance
art / entertainment application
non-task oriented dialogue
information retrieval
semi-supervised learning

\Recognition and estimation/
State change detection

recognize objects or what's heard from image, video, or sound information

[Keyword] (continued from the front)

transfer learning
deep learning
adversarial learning
artificial neural network
gesture recognition
clustering
sparse modeling
knowledgebase
knowledge acquisition / discovery

medical / healthcare application
kansei engineering
action estimation
affordance
cloud sourcing / human computation
video processing

\Recognition and estimation/
Authentication

give an index to the nature of an object under complex and ambiguous criteria

[Keyword] (continued from the front)

auction
kansei engineering
onomatopoeia
knowledge graph
ontology
dialogue processing / dialogue systems
multi-agents
cloud sourcing / human computation

[related fields]
marketing research, management studies, product design, natural language processing

\Collaboration and trust formation/
Mediation and planning

support fair consensus building and give advice on ethical issues

[Keyword] (continued from the front)

knowledge acquisition / discovery,
knowledge graph
AI ethics,
privacy
computational social sciences
behavioral economics
Behavior modification (nudge)
shikakeology
application of social issues
auction

game theory
kansei
decision making and consensus building
swarm intelligence
human-agent interaction
fuzzy logic
constraints satisfaction problem / satisfiability testing (CSP/SAT)

\Analysis and summarization/
Media data analysis

clearly show analysis results by inspecting big and various image / video data

[Keyword] (continued from the front)

representation learning (embedding)
semi-supervised learning
clustering
sparse modeling
multi modal analysis

speech recognition
video image processing
art / entertainment applications
affordance

[related fields]
optics, acoustics, mechanical vibration engineering, preprocessing, data cleansing, noise reduction

\Analysis and summarization/
Causal inference

find causal relationship based on data; predict what changes what

[related fields]
statistical causal analysis, design of experiments randomized controlled trials, stratified analysis econometrics

\Analysis and summarization/
Summarization

clearly show the gist of large amount of information

[Keyword] (continued from the front)

information retrieval
deep Learning
sparse modeling
representation learning (embedding)
information visualization
conversation understanding / discourse understanding / intention understanding

pattern recognition
image generation
knowledge sharing / management
ontology
knowledge graph
knowledge base

[related fields]
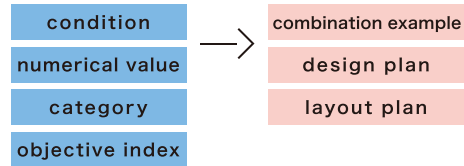
information retrieval

\Design/
Placement and design
decide complicated arrangements and combinations to meet the required conditions

[application example keywords]
production planning, procurement planning, personnel shift, investment planning, layout planning, layout optimization, shelving allocation

condition	→	combination example
numerical value		design plan
category		layout plan
objective index		

[Keyword]
planning
constraints satisfaction problem / satisfiability testing (CSP/SAT)
genetic algorithm
simulation
evolutionary computation
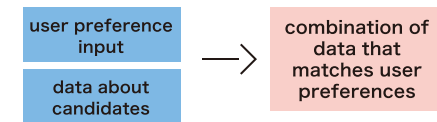graph theory
multi-agent
heuristics
《continued to the back》

\Design/
Coordination
show proposals from many combinations

[application example keywords]
fashion, travel plans, class attendance plans, food menus

| user preference input | → | combination of data that matches user preferences |
| data about candidates | | |

[Keyword]
information recommendation
genetic algorithm
kansei
onomatopoeia
constraints satisfaction problem / satisfiability testing (CSP/SAT)
evolutionary computation
art / entertainment application
knowledge base
knowledge acquisition / discovery
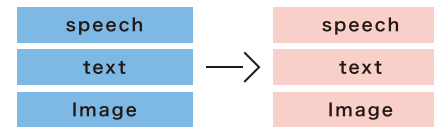《continued to the back》

\Generation and dialogue/
Speech dialogue
respond appropriately by understanding people's intentions based on natural language, intonation, facial expressions, etc. (paralanguage)

[application example keywords]
handling at the counter, call center, web service, elderly people support

speech	→	speech
text		text
Image		Image

[Keyword]
dialogue processing / dialogue system
speech recognition
speech generation
non-task-oriented dialogue
conversation understanding / discourse understanding / intention understanding
HAI
《continued to the back》
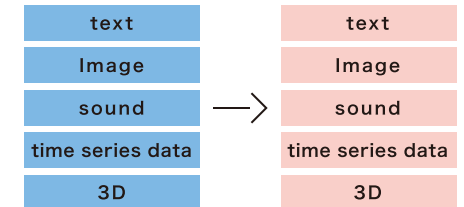
[related methods / technologies]
cognitive science

\Generation and dialogue/
Media transformation
generate target data by transformation or augmentation of input data

[application example keywords]
photo, line art, manga, 3D, speech quality, image compression

text	→	text
Image		Image
sound		sound
time series data		time series data
3D		3D

[Keyword]
image generation
speech generation
adversarial learning
deep learning
pattern recognition
ontology
《continued to the back》

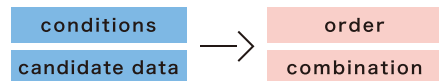[related methods / technologies]
Style Transfer, VGG, GAN, Cycle GAN

\Collaboration and trust formation/
Ordering and selection
show appropriate selection criteria or order, and present candidates for selection

[application example keywords]
screening, tournaments, selection

| conditions | → | order |
| candidate data | | combination |

[Keyword]
planning
constraints satisfaction problem / satisfiability testing (CSP/SAT)
genetic algorithms
knowledge sharing / management
knowledge acquisition / discovery
AI fairness
social problem application
market design
multi-agent
decision-making and consensus building
information visualization
swarm intelligence
sparse modeling
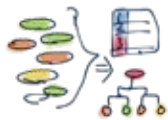
\Generation and dialogue/
Knowledge organization
understand and structuralize meaning from documents for extracting relevant knowledge

[application example keywords]
FAQ generation, Web search, risk assessment, investment decision, information retrieval, data sharing, knowledge sharing

| document | → | text |

[Keyword]
ontology
summarization
knowledge sharing / management
crowdsourcing
knowledge graph
text mining
web interaction
expert system
onomatopoeia
intelligent UI
《continued to the back》

[related methods / technologies]
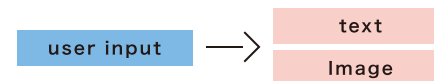database, knowledge management, philosophy

\Generation and dialogue/
Advice
display candidates that match the user based on expert knowledge and considering complex influences

[application example keywords]
finance, health care, legal consultation, fitness, daily matters consultation, energy conservation, safe driving

| user input | → | text |
| | | Image |

[Keyword]
information recommendation
reinforcement learning
expert system
knowledge base
dialogue processing / dialogue system
knowledge acquisition / discovery
AI ethics
HAI
《continued to the back》
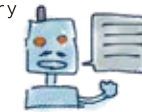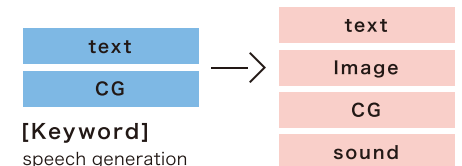
[related methods / technologies]
A/B test

\Generation and dialogue/
Media generation
Automatically generate article, conversation or CG from data

[application example keywords]
news article script, CG of sign language, novel, music

text	→	text
CG		Image
		CG
		sound

[Keyword]
speech generation
image generation
video processing
conversation understanding / discourse understanding / intention understanding
summarization
knowledge sharing / management
ontology
《continued to the back》

[related methods / technologies]
GAN, DeepFake, StyleGAN, speech synthesis, Text to Speech (TTS)

Media transformation

generate target data by transformation or augmentation of input data

[Keyword] (continued from the front)

knowledge graph
knowledge base
conversation understanding /
discourse understanding /
intention understanding
information visualization
art / entertainment application
VR

Speech dialogue

respond appropriately by understanding people's intentions based on natural language, intonation, facial expressions, etc. (paralanguage)

[Keyword] (continued from the front)

multimodal interaction
kansei
gesture recognition
HRI
symbol emergence in robotics
behavior estimation
shikakeology
business applications
biomedical and health care applications
speech generation

Coordination

show proposals from many combinations

[Keyword] (continued from the front)

game theory
distributed collaboration

Placement and design

decide complicated arrangements and combinations to meet the required conditions

[Keyword] (continued from the front)

market design
business application
distributed coordination

Media generation

Automatically generate article, conversation or CG from data

[Keyword] (continued from the front)

knowledge graph
adversarial learning
deep learning
pattern recognition
HAI
kansei
intelligent UI
bioinformatics
materials informatics
art / entertainment application

[related fields]
hidden Markov model (HMM), Deep Belief Network, spectral envelope

Advice

display candidates that match the user based on expert knowledge and considering complex influences

[Keyword] (continued from the front)

multimodal interaction
statistical learning
computational learning theory
kansei
intelligent user interface
conversation understanding /
discourse understanding /
intention understanding
HRI
Web interaction
behavior modification (Nudge)
onomatopoeia
text mining

ontology
knowledge graph
knowledge sharing /
management
fuzzy logic
collective intelligence
well-being computing
educational applications
behavioral economics
information retrieval,
auction
decision making /
consensus building
skill science
embodiment
speech generation

[related fields]
medical science
economics
Jurisprudence

Knowledge organization

understand and structuralize meaning from documents for extracting relevant knowledge

[Keyword] (continued from the front)

knowledge base
knowledge acquisition / discovery
decision making / consensus building
social media
information recommendation

Ordering and selection

show appropriate selection criteria or order, and present candidates for selection