AI Map Beta

Overview of AI research for beginners
and interdisciplinary researchers

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The Japanese Society for Artificial Intelligence, AI Map task force

AI Map Beta

Overview of AI research for beginners and interdisciplinary researchers

Artificial intelligence (AI) research has expanded greatly this century, making it difficult to capture the whole picture. Therefore, we have created the 'AI Map' series of maps to provide sketches of this picture to help new AI researchers with their future work as well as researchers in other fields who would like to use AI (Fig. 1).

There are many areas of AI research. These areas are intricately linked and developing rapidly so it is difficult to fit the relevance of all research fields into a single map without contradiction. Therefore, for the beta version of the AI Map, we created four maps that capture AI research from four different perspectives (Fig. 2).

The four maps are beta versions and we plan to improve them further. We also expect that volunteers will produce additional maps. For example, experts in specific fields will create partially detailed maps as well as tutorials, and these maps will be linked to the beta versions.

As an introduction, we describe the four maps and illustrate their usage.

Map A focuses on the process of intelligence. The concept of intelligence as an input/output process flow is shared by many AI researchers, and research on each step of this process is ongoing. This map is intended to be used to develop fundamental research to realize complex processing, or to deconstruct intellectual processing. In addition, the viewpoints of individual intelligence and group intelligence are included in this map.

Map B shows the relationship between technologies and applications. Many AI studies research fundamental technologies with limited targets. This map shows representative pairs of technologies and objects. Because there have been many successful studies in which the target shifted, the next successful area may center on individual keywords. The map is intended to show how to shift research targets as well as the peripheral technology used for applications.

Map C focuses on the foundations that AI research rests on and AI's various applications. AI research is a highly interdisciplinary field broadly based on natural sciences, humanities, and social sciences. In addition, the map shows important areas of application. This map is intended as a reference when reviewing fundamental research or when exploring new applications.

Map D shows AI researchers' various answers to the question "What is intelligence?". One researcher answered "learning, recognition, and prediction". Other research is pursuing various aspects of intelligence, such as "inference, knowledge, and language" as well as "discovery, search, and creation", and how these aspects mutually affect one another. This map is intended to show the spread of AI research and the depth of the research field. The frontier of AI research is broad.

[Keywords]

Each map has keywords that represent AI-related research fields.

The keywords were selected by the task force from among those used in academic journals, by special interest groups, and so on, based on whether the keywords are suitable for representing the overall picture of AI research.

Because the applications of AI are constantly expanding, we focused on application keywords that the task force identified as important at the time the map was published. (Example: materials informatics.)

The target ranges of the keywords overlaps, and the size of the granularity and the degree of abstraction have some variation.

The keywords in the maps do not match because some keywords are not visible in some maps.

Each map also includes keywords in broader research fields beyond AI, in which case these keywords represent AI research in the field. (Example:information search.)

The maps also include keywords for other research fields and application fields that are closely related to AI research. (Example: behavioral economics, standardization.)

Other important keywords may be missing. We encourage researchers to suggest new keywords.

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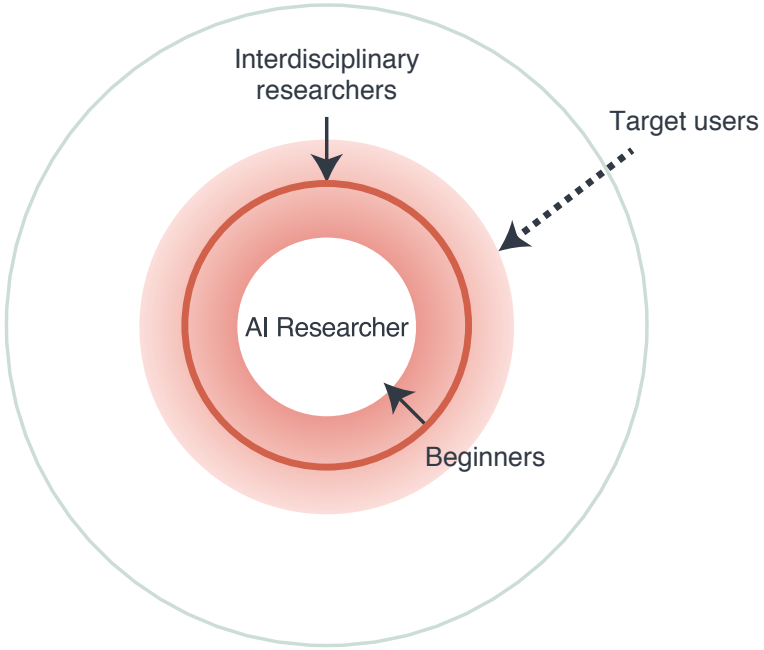

Figure 1. Main target users of AI Map Beta

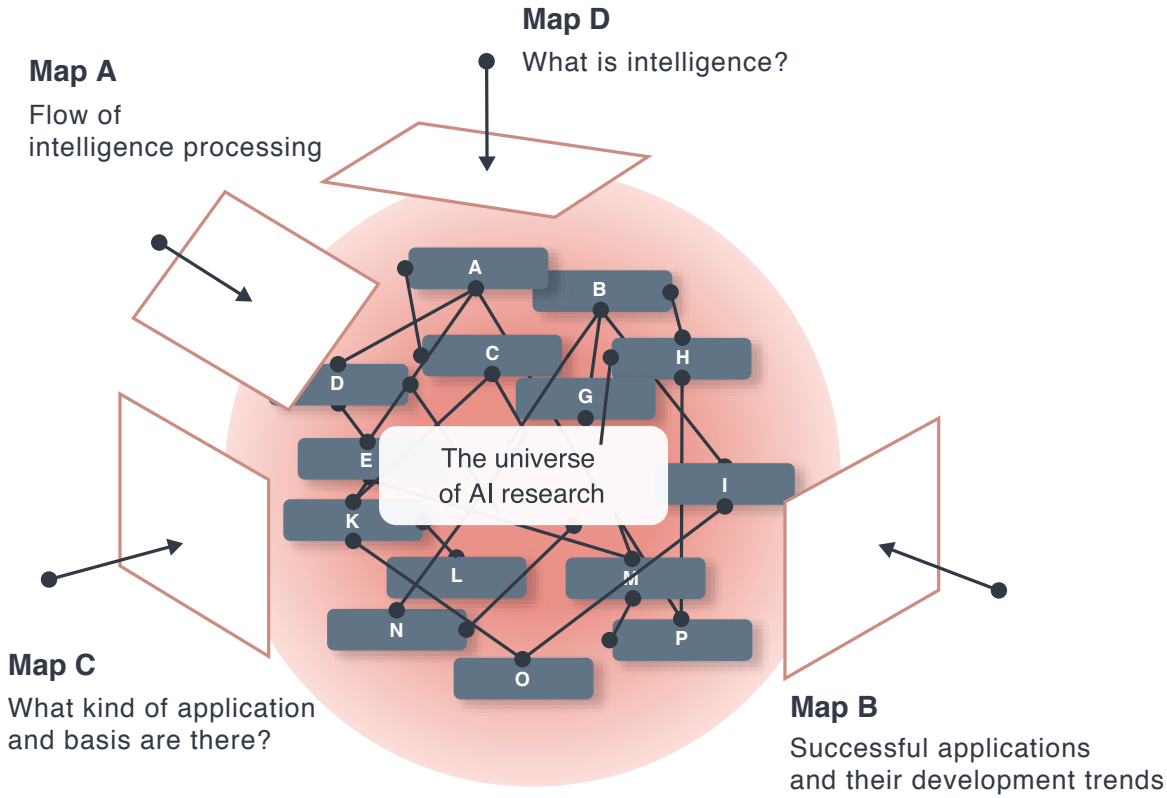

Figure 2. Relationship between the whole of AI research and AI Map Beta

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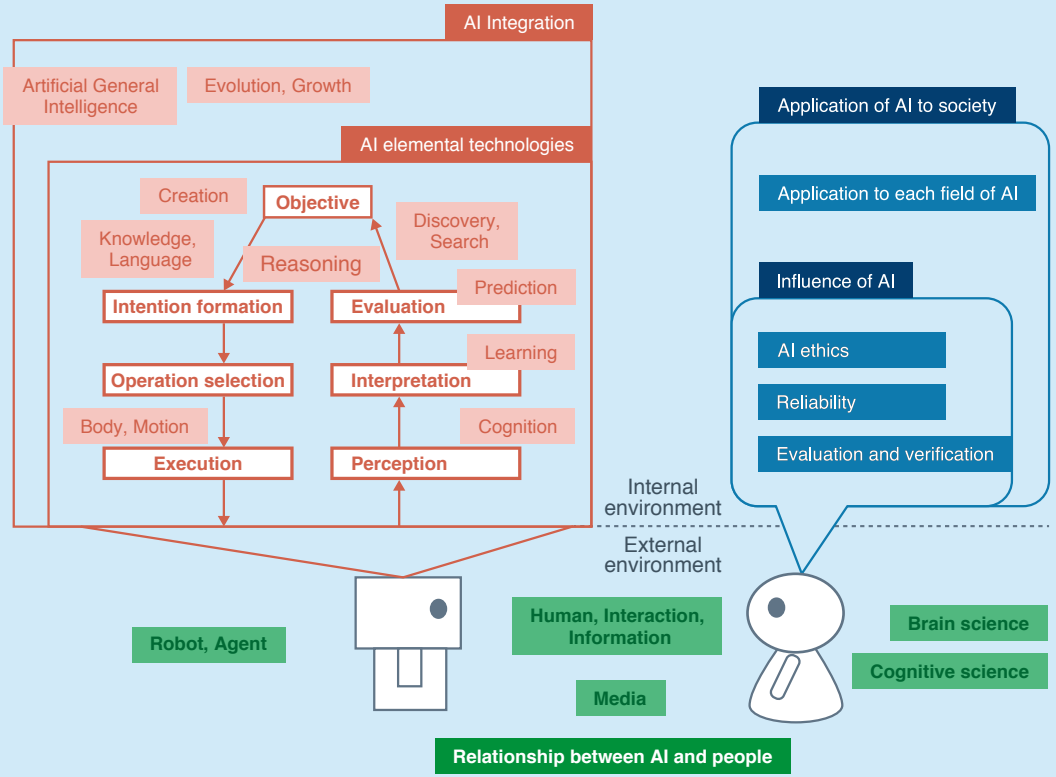
Flow of intelligence activity

AI research sees human activity as a flow consisting of a combination of many intellectual activities. There are research fields that correspond to each step in this flow. Humans perceive and interpret the visual image, pay attention to the required information, evaluate the information based on the selected information, form an intention, and decide a series of operation sequences. For example, let's consider a fellow researcher who approaches while holding out his right hand. I recognize the right hand approaching and identify the person as non-Japanese. In addition, his expression is friendly. I remember that there is a custom of shaking hands in foreign countries. I combine the recognition, and construct a series of actions, such as putting out my right hand, smiling while making eye contact, and shaking his hand.

AI also needs to work with humans by communicating with the people around it, and this involves many areas of research. For example, one area of research studies the interaction and dialogue between humans and robots with physical bodies.

In addition, many new research fields are emerging that examine how humans view AI. Research is also required on the appropriate use of AI, and includes evaluating AI's reliability and operability.

Novices can learn about applications and activities related to their academic fields. For those who are already researching a certain field, the map can show related AI research themes and highlight possible partners for collaboration.



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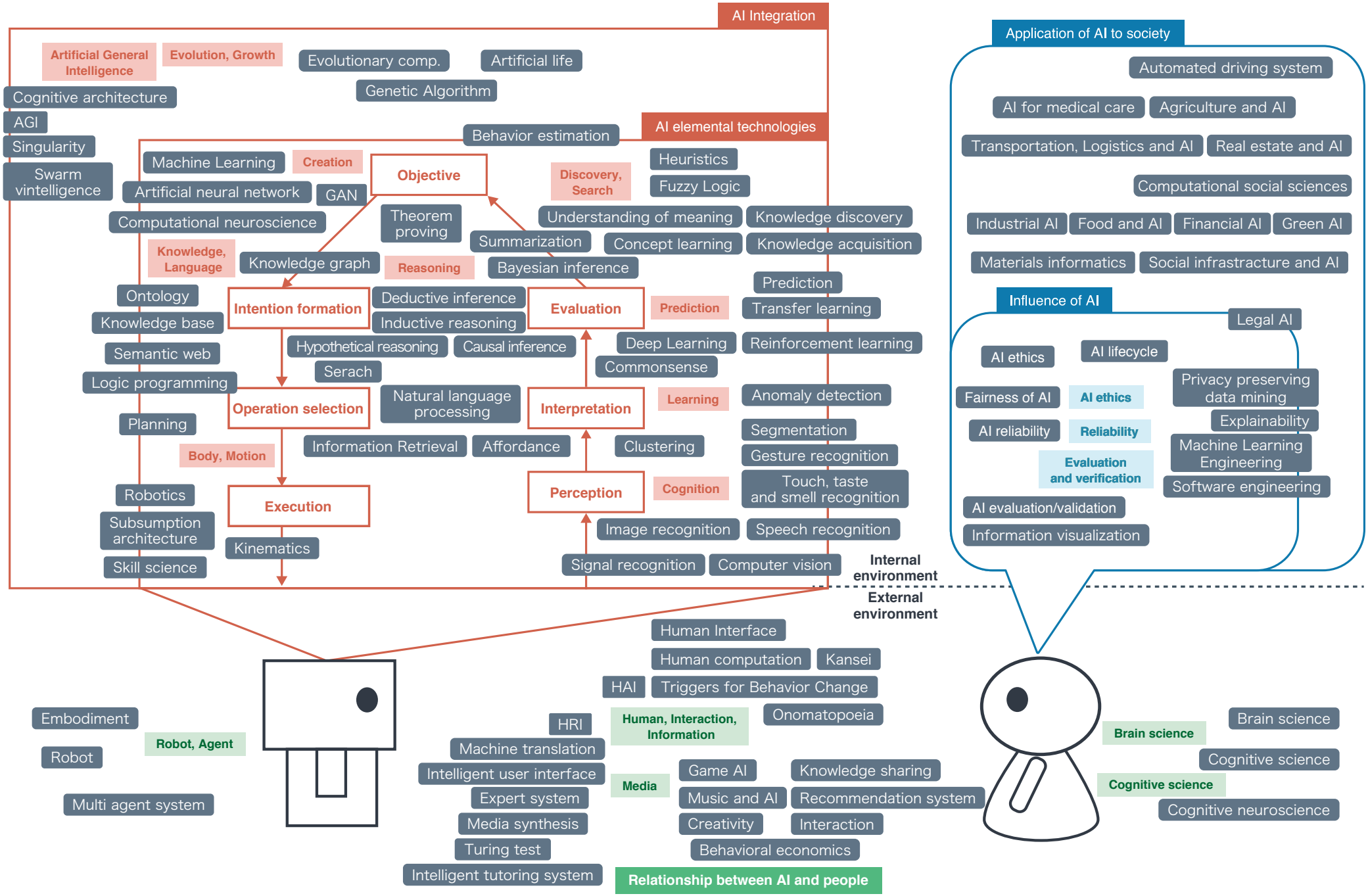

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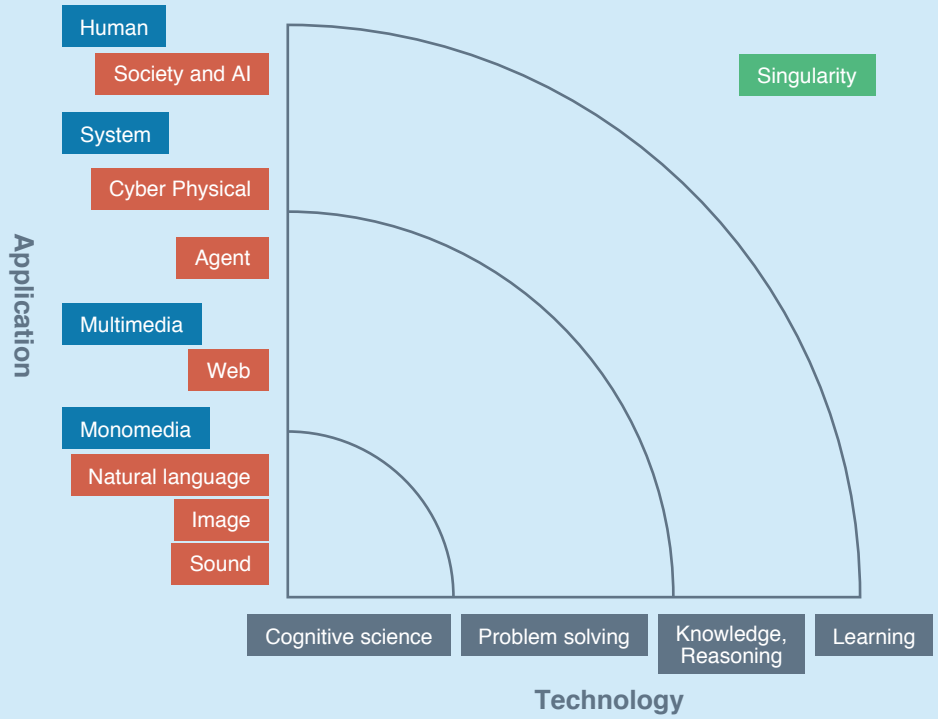
B

Matching technology and applications with the next target

AI research has produced a large number of technologies that are general-purpose with no specific target. However, during development, targets have been defined within a certain range, and realization methods and fundamental technologies have been developed for them. For example, image targets have evolved from simple signal recognition to complex image recognition, and then to generative adversarial network (GAN).

In addition, technological development in a specific field has stimulated related technical fields, and has created new technology-target pairs. Therefore, the area around coordinates that is currently producing a large number of new technologies could be developed by changing the target or changing the technical goal.

For example, as a hypothesis, in recent years the practicality of multi-agent systems has been rapidly improved by increases in computing power and the preparation of large amounts of data. Looking at surrounding areas on the map, scheduling is likely to be closer to problem solving, and as the target moves closer to knowledge and reasoning, new technological advances may emerge in multi-agent systems (e.g., the Semantic Web).



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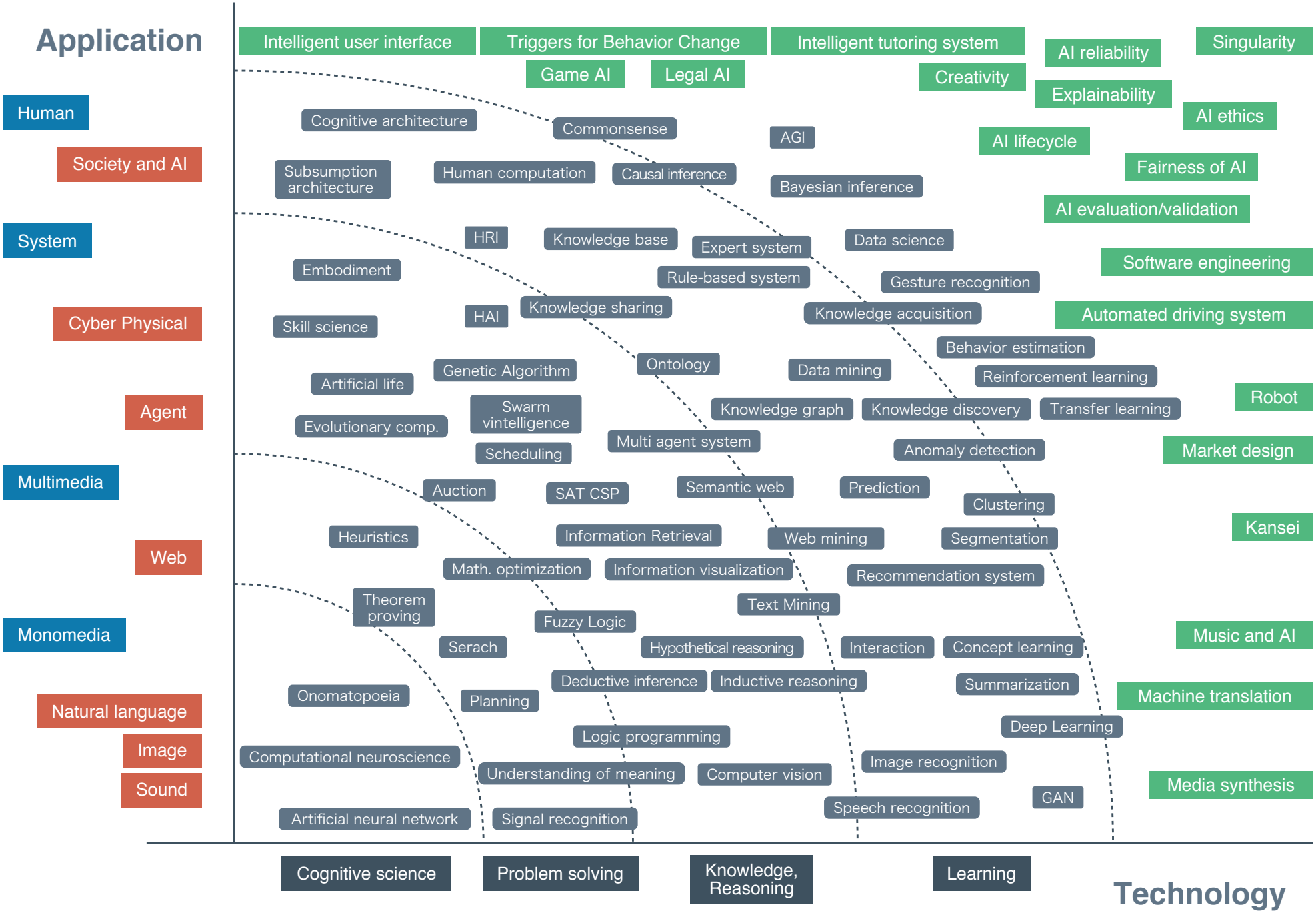

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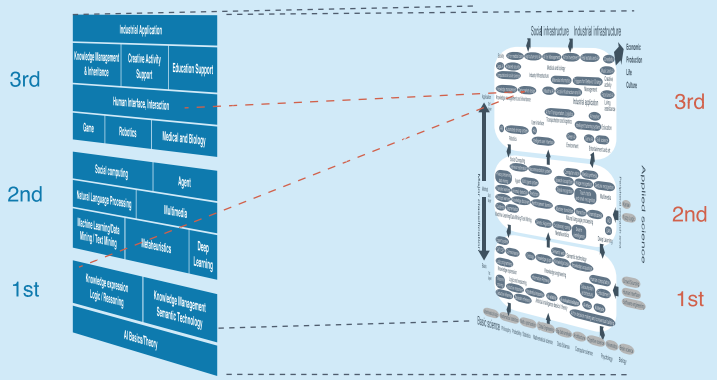
C

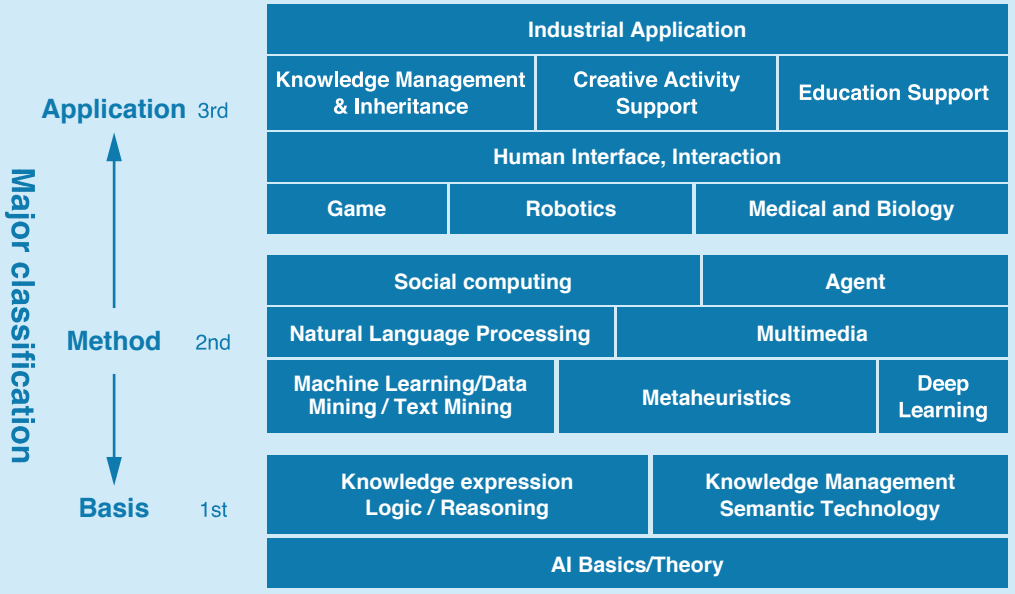
Connectivity of fundamentals with methods and applications

Map C shows how the roots and branches of AI research spread widely.

AI is built on many fundamental disciplines, including mathematics, statistics, logic, cognitive science, and neuroscience. Of course, it is impossible to master all these subjects before you start AI research. However, it may be useful to return to the basics before aiming to go beyond the horizon of current research. Along with reading the latest papers and comparing and evaluating the latest libraries on GitHub, it is also worthwhile spending time studying the fundamentals.

Map C shows the scope of AI applications, which is rapidly expanding. Applications will probably extend to every aspect of human society as practicability improves. As a starting point, the map shows the application areas that are now booming. For example, AI is used in various fields such as financial technology, medicine, real estate, music, and agriculture. In addition, as the applications expand, new technical issues and social issues are emerging, including ethics, credibility, and explainability. These are fed back as learning into the foundations of AI, and the large tree of AI research spreads further.





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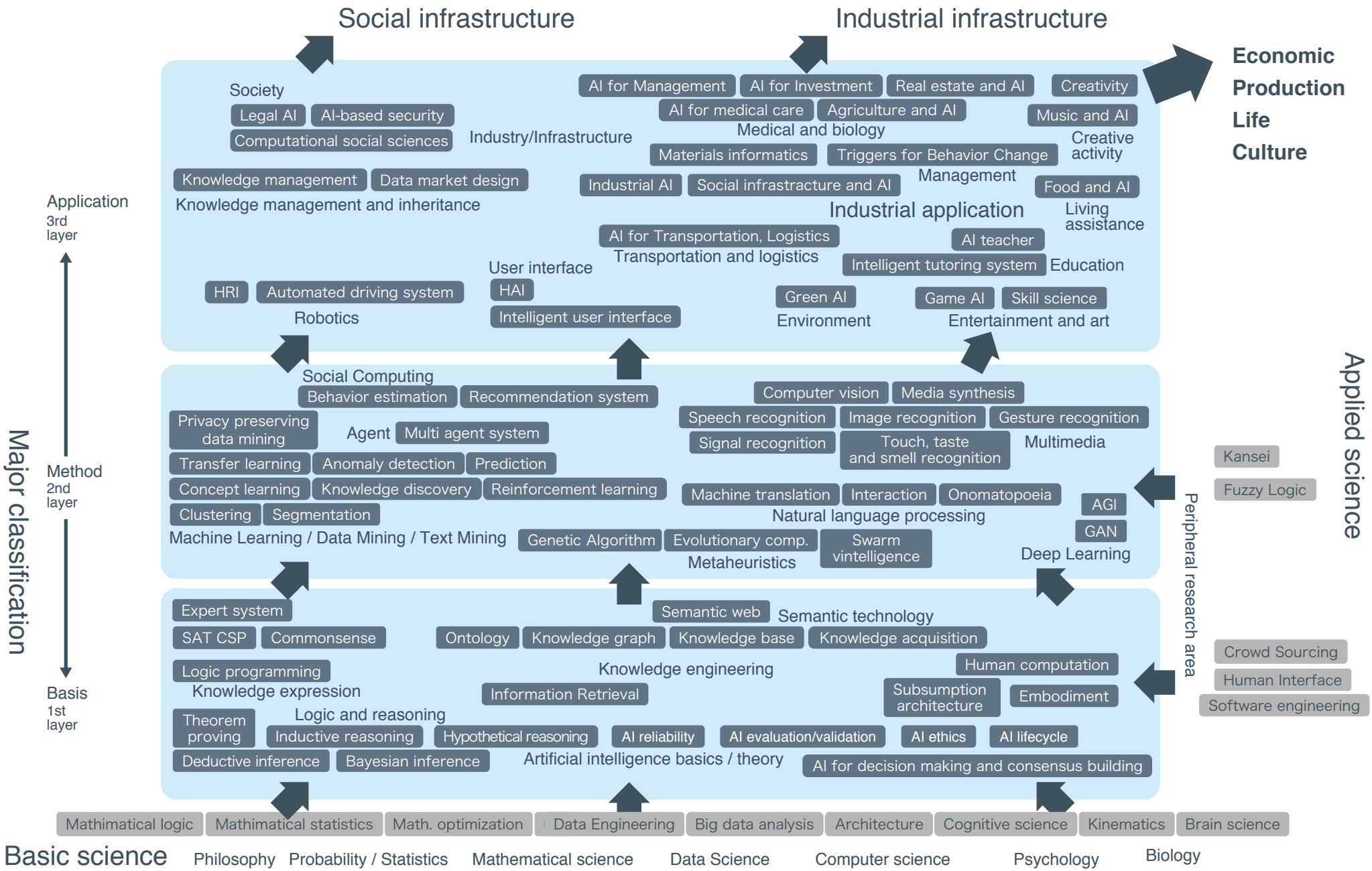

* An example of interpretation : Inductive inference is created based on probability / statistics and mathematical science, machine learning technology develops, prediction technology advances social infrastructure AI, and contributes to infrastructure maintenance, environmental conservation, and economic activity development

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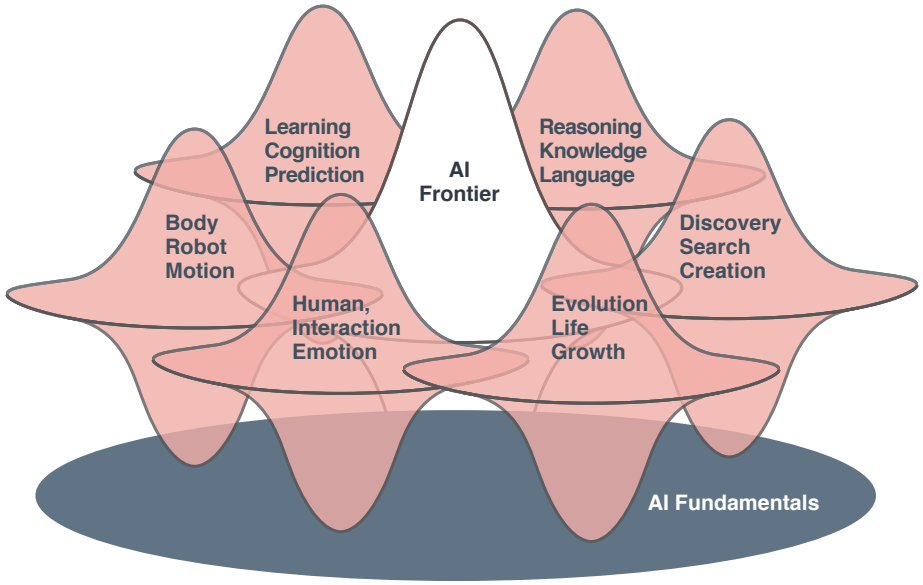
AI research is diverse

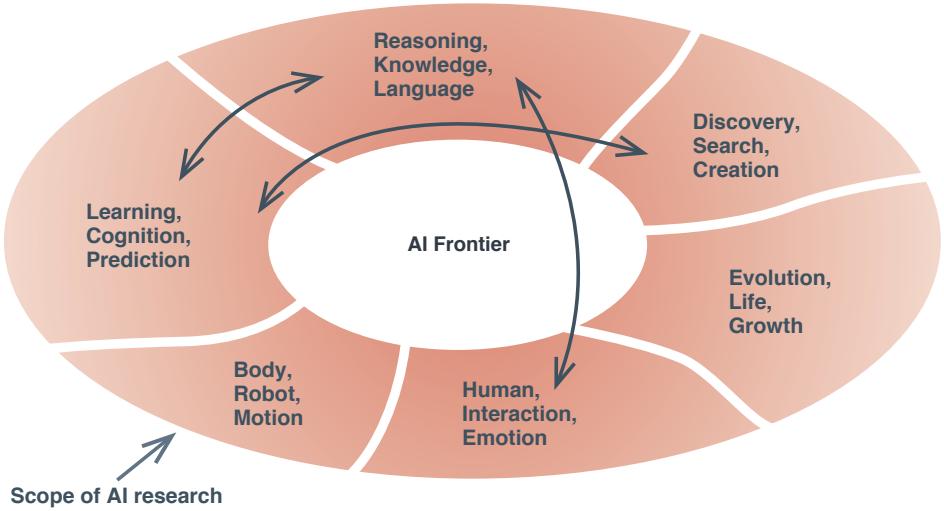
The vast frontier of AI

In AI research, there are various approaches for realizing mechanical intelligence. The ultimate goal of the "AI frontier" is the realization of intelligence comparable to or beyond that of humans and other living things, and its integration into society. In the surrounding area of the map, there are multiple viewpoints with different ways of thinking about intelligence that continue to be studied in depth, and each has made steady scientific and technological progress. Furthermore, AI research is related to many other research fields, and through close coordination with these other fields it can split from or fuse with other fields, opening up new horizons.

For example, in this map, the area of “reasoning, knowledge, and language” (also called “adult intelligence”) is shown in the upper right of “learning, recognition, and prediction”. Humans can use words, build and share knowledge, and make various inferences. Some of these processes are formalized in AI research and have theoretical explanations and practical applications. In this area, new technologies and research directions are being developed with data-driven approaches. In addition, research is beginning to show that language and reasoning influence recognition itself.

To keep the map in a single plane, two main adjacent areas were used. However, in practice, fusion with the opposite region across the AI frontier is also popular. For example, the relationship between “reasoning, knowledge, and language” and “human, interaction, and emotion” is deep, and “onomatopoeia" is a research field located between these two opposite fields. In addition, image generation using GAN which is an application of deep learning, is a fusion of “learning, recognition, and prediction” and “discovery, search, and creation”. Future AI research may have great potential for merging areas that do not have deep links.





AI research is developing in conjunction with a number of academic disciplines around it. The closer to the center, the more AI-specific or unresolved / undefined problems.

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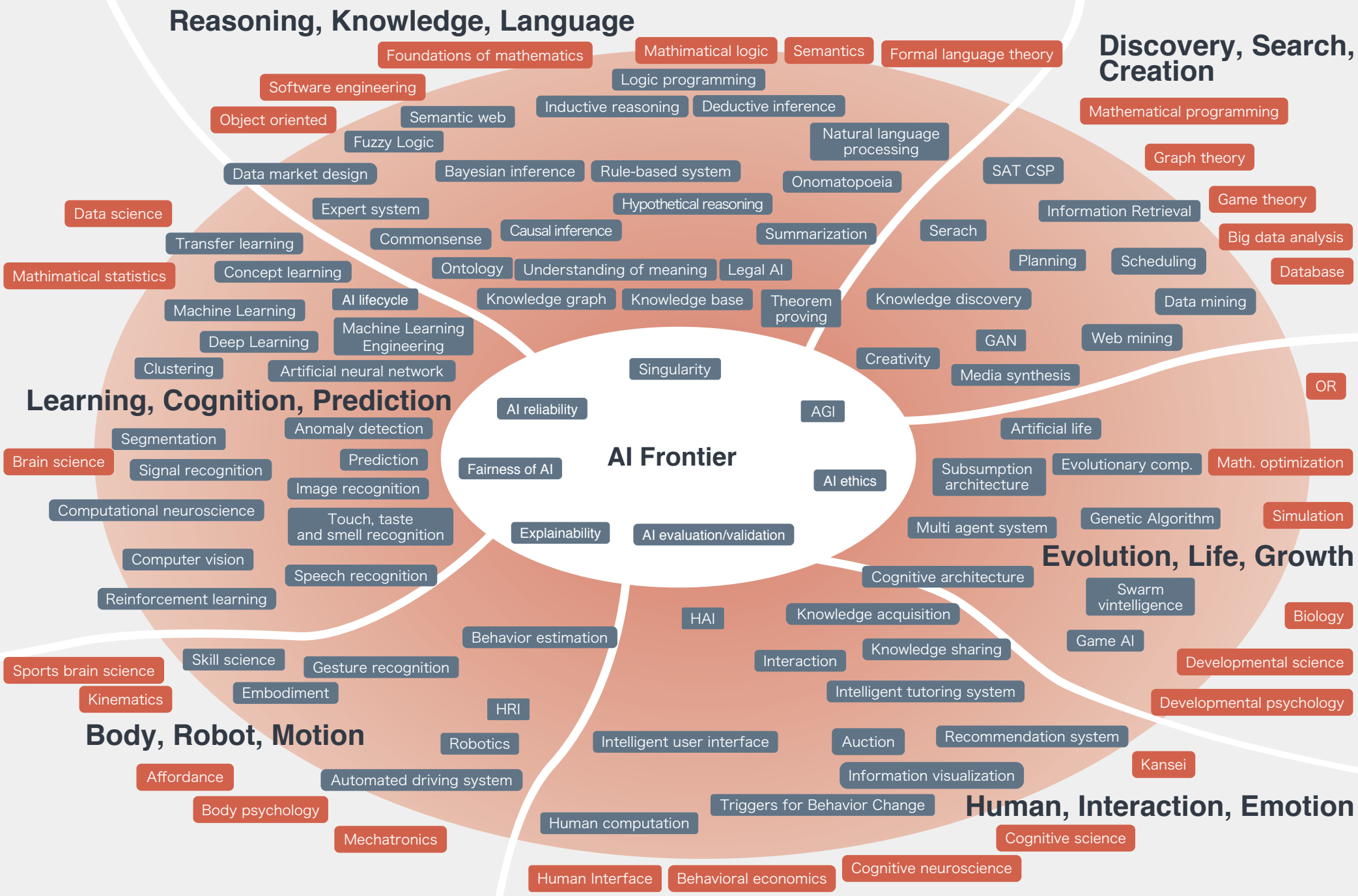

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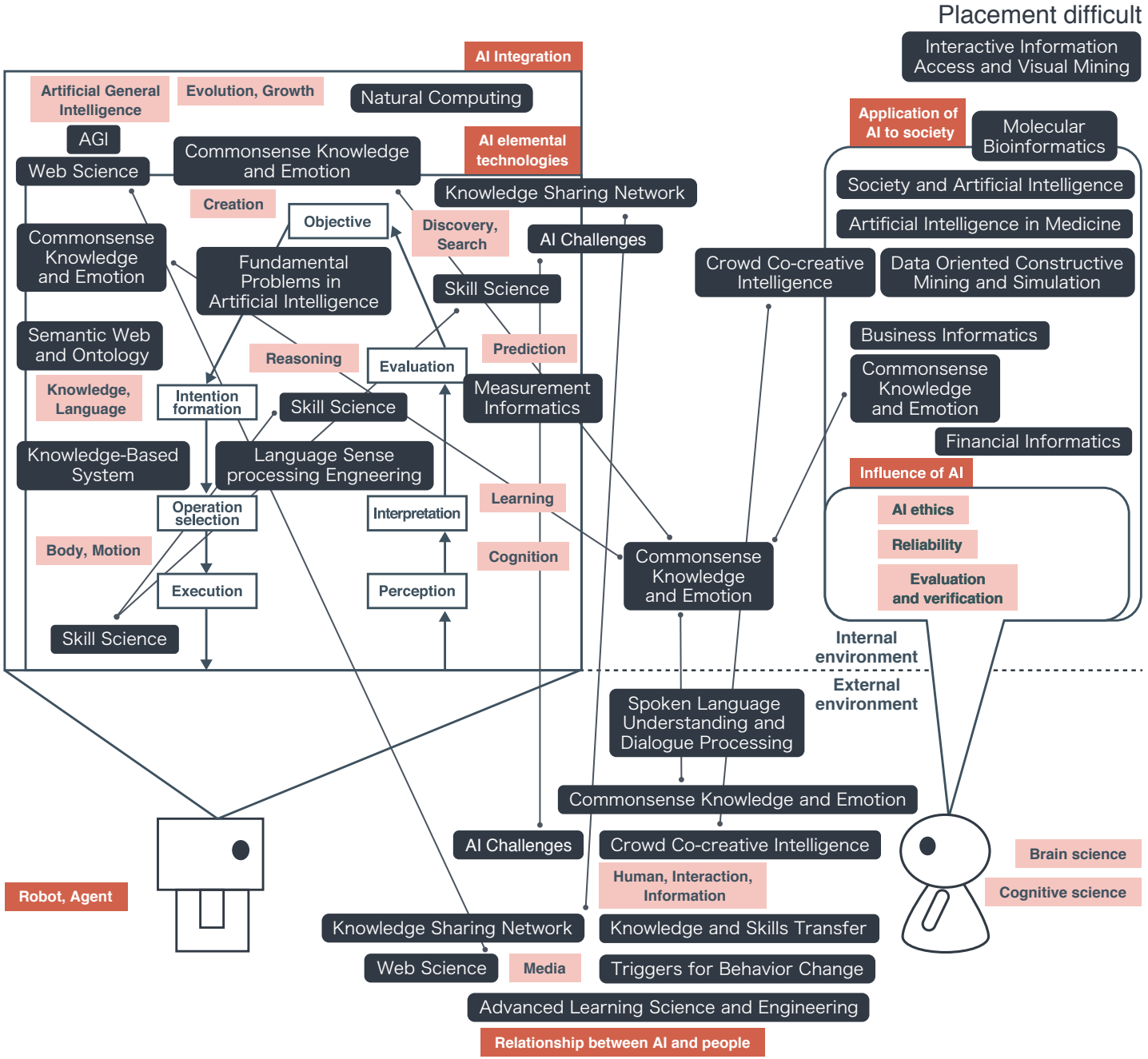
Map of special interest groups in the Japanese Society for Artificial Intelligence

There are 24 special interest groups (SIGs) in the Japanese Society for Artificial Intelligence (JSAI). The following website provides information on SIGs.
https://www.ai-gakkai.or.jp/sig/sig-list/

For beginners and interdisciplinary researchers who are interested in AI research, active participation in SIGs is desirable for obtaining up-to-date research information and making contact with front-line researchers.

However, it is difficult to link the names of groups, titles of papers, and users' interests. Therefore, we have created maps of the groups that overlap with AI Map, beta version to encourage participation.



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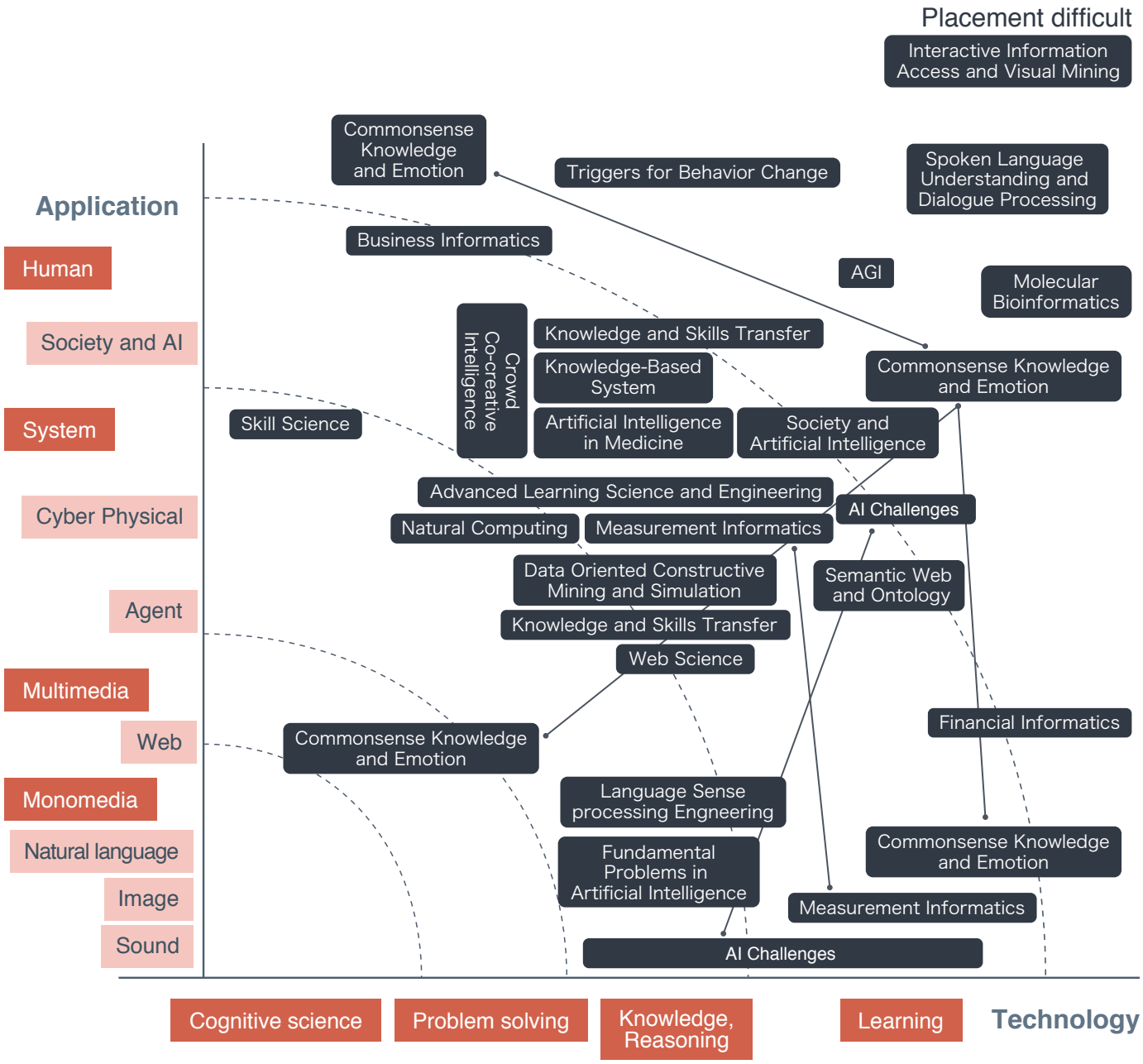

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However, it is difficult to link the names of groups, titles of papers, and users' interests. Therefore, we have created maps of the groups that overlap with AI Map, beta version to encourage participation.

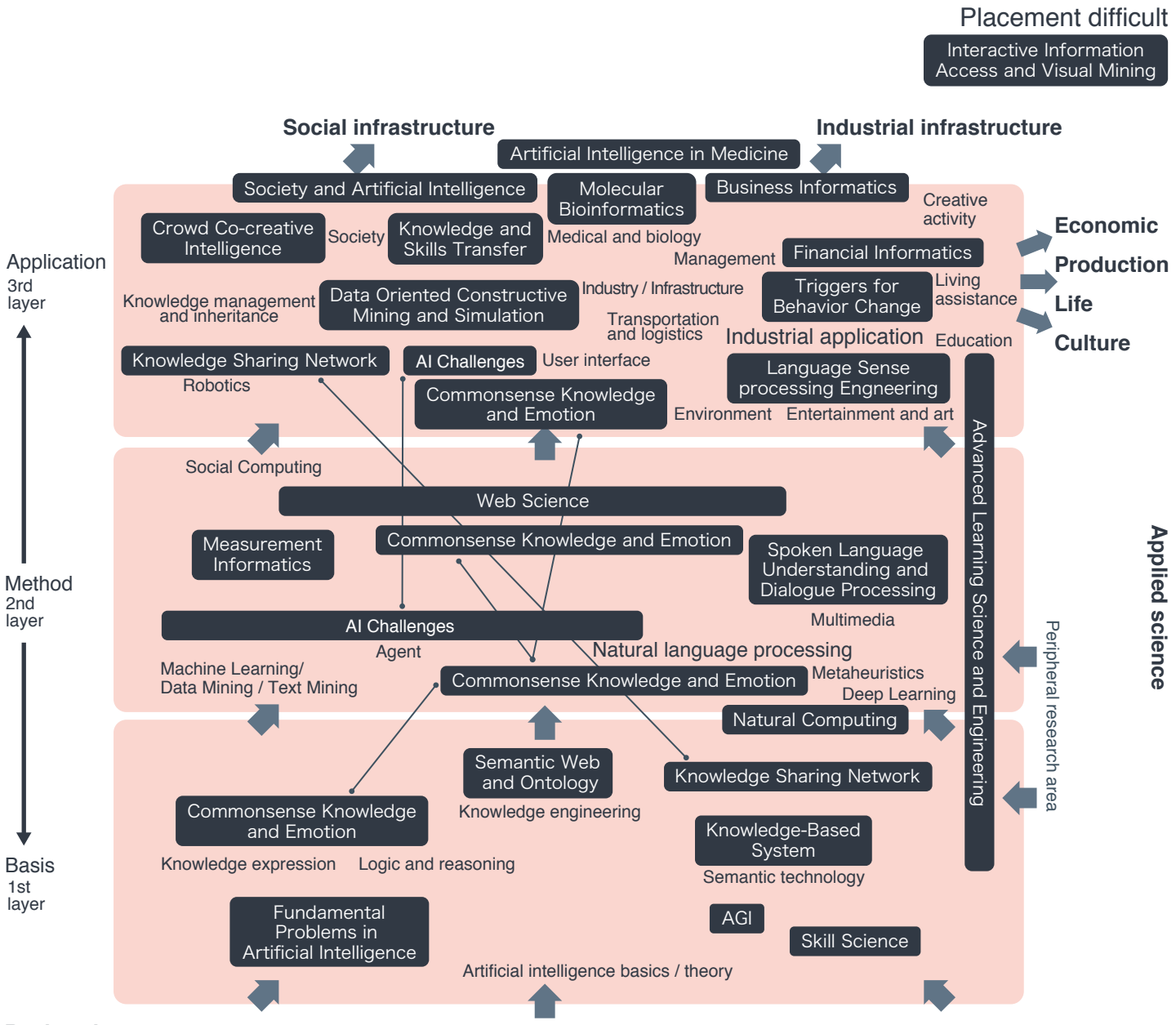
The four SIG maps shown here were created based on the results of a questionnaire answered by the leaders of each group. The maps are arranged to ensure maximum visibility.

There were several groups that were difficult to place on a specific map because of their diverse scope, so we have placed them outside of the maps. In addition, some groups are combining or simultaneously handling distant areas on the map. We have shown the spread of the target area by connecting areas with a line or vertically and horizontally.

These maps show the areas where research groups are concentrated, and the similarities between groups.

The JSAI holds joint research meetings of the SIGs once a year. Joining neighboring groups on the map will allow researchers to grasp the latest research trends in related areas quickly.

In addition, the areas in which the groups are concentrated on the map are likely to be hot topics in AI research and will highlight current research trends.



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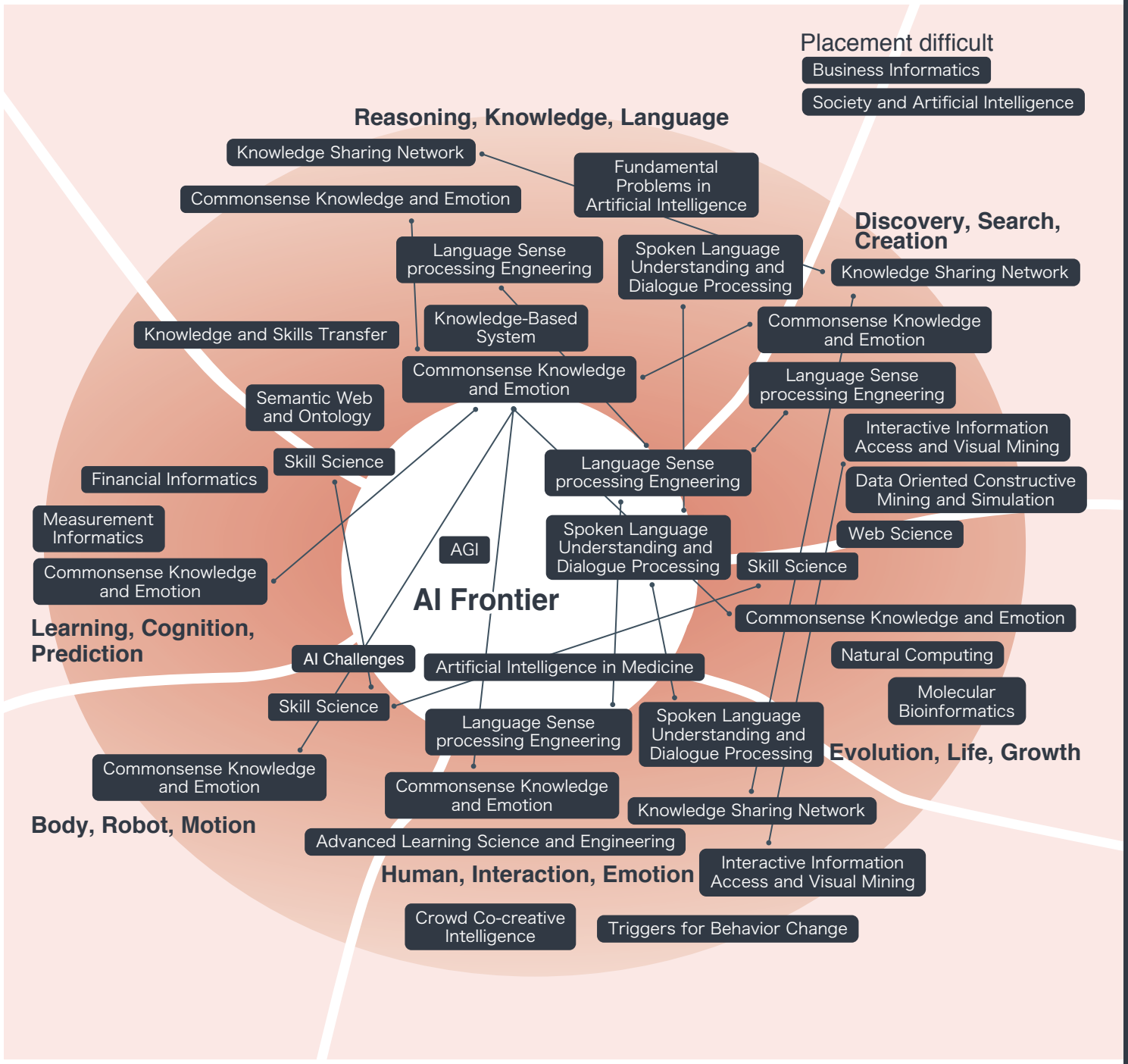

List of SIGs

- AGI : Artificial General Intelligence
- AIMED: Artificial Intelligence in Medicine
- ALST : Advanced Learning Science and Engineering
- AM : Interactive Information Access and Visual Mining
- BI : Business Informatics
- CCI : Crowd Co-creative Intelligence
- Challenge: AI Challenges
- CKE : Commonsense Knowledge and Emotion
- DOCMAS: Data Oriented Constructive Mining and Simulation
- FIN : Financial Informatics
- FPAI : Fundamental Problems in Artificial Intelligence
- KBS : Knowledge-Based System
- KSN : Knowledge Sharing Network
- KST : Knowledge and Skills Transfer
- LSE : Language Sense processing Engneering
- MBI : Molecular Bioinformatics
- MEI : Measurement Informatics
- NAC : Natural Computing
- SAI : Society and Artificial Intelligence
- SKL : Skill Science
- SLUD : Spoken Language Understanding and Dialogue Processing
- SWO : Semantic Web and Ontology
- TBC : Triggers for Behavior Change
- WebSci : Web Science

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Future development and requests

Additional maps

In the map, we only used four viewpoints; however, while we were creating the map, we were asked whether we could create various other related maps. Some of the requests are shown below. We would like to take these requests into consideration when making future updates.

(1) Data-driven interactive map

The JSAI has many high-quality documents, such as papers, journals, and workshop reports, which contain many keywords. Therefore, a map automatically created from these documents could be created by visualizing mined text. Furthermore, converting the map to interactive Web content that allows users to walk through multiple viewpoints would allow the spread of AI research to be understood in three-dimensions.

(2) Learning support map for beginners

Beginners also need maps that can be used as guides to deepen their understanding and gain practical knowledge that can be used for research. For example, it is useful to know which fundamental academic fields can contribute to the basis and applications of image recognition. In addition, journals provide a wealth of knowledge, and there are many tutorial articles that help beginners. A guide to the month and year of issue of journals will improve a beginner's ability to gather information.

(3) Major conference map and conference session map

There are numerous domestic and international conferences related to AI research. Maps showing their relevance are also useful for efficient article submission and information gathering. In addition, at annual conferences, a large number of general and organized sessions are held, which are wider in scope than the SIGs. Maps of these sessions will also help to make the events meaningful.

Join the Japan Society for Artificial Intelligence

The beta version of AI Map was created as part of the activities of the Japan Society for Artificial Intelligence. If you are interested in this map, we would recommend joining JSAI. Members can access useful information, such as academic journals with articles on the latest AI research and applications. In addition, members can contribute to annual conferences, SIGs, and journals, and get discounts on participation fees for events such as seminars. The admission process is detailed on the following homepage (URL).

https://www.ai-gakkai.or.jp/about/membership/

Recruitment of people who would like to make new maps

Every AI researcher will have a map based on his or her own perspective and a map of his or her field of study. In addition, for each SIG, you may be able to create a map showing research trends in each field, or a tutorial for beginners in the research group. JSAI supports the creation of new maps. In addition, we intend to recruit researchers who will help update the next version of AI Map.

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https://apricot-design.com/

Contact information on AI Map: info [at] ai-gakkai.or.jp

(Convert [at] to @)

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