【参考資料2-2】

Matrix for deriving common issues across cases

Ethical Issues

Mobility		Manufacturing		Personal services (including medical care and finance)		Conversation/Communication		Common Issues
Mobility-A (autonomous vehicle): Autonomous vehicles will execute accelerating, braking, and steering instead of a human driver, using vehicles' sensors such as cameras, radars, and GPSs with traffic information from external networks, enabling them to drive on highways or jammed roads reducing the driver's workload. Autonomous vehicles will reduce the psychological load and physical workload of elderly people who have concerns regarding dynamic vision and quick action through AI support. Even when a driver becomes unable to control a car due to an accident, the autonomous vehicle can safely control and park the car.	Who should decide, and how, the priority of accident avoidance? (Should humans decide behaviors to avoid accidents except for stopping?)	Manufacturing-A (automated factory): Robot arms with AI will be able to handle any objects, regardless of their shapes and orientations, without complicated programing. Accordingly, manufacturing of a wide variety of products in small quantities and for various needs will be realized with low costs. Factory robots will learn specialist skills, enabling them to perform specialist skills and contribute to other workers learning specialists' implicit skills. Power-assisting robotic suites (exoskeleton) will reduce the physical workloads of workers.	Does the value of humans' learned skills change when AI can perform the same skills? Are there any differences in value between a robot's skills learned from specialists and specialist humans' skills, and how are they evaluated?	Services-A (medical care, diagnosis): Predicting health status and doctors' diagnoses will be supported by AI using daily-life data and/or DNA sequences. Based on these, how to change one's lifestyle, how to prevent diseases, and medical care can be proposed optimally for individuals.	Prediction of health status or diseases will be accurate even before symptoms appear. Should we reconsider patients' right to (not) know a diagnosis and doctors' duty to tell? Might predictive diagnosis increase politically incorrect discrimination between healthy people and others?	Conversation-A (conversation agent): Conversation agents speaking and understanding users' native language will be useful for all people, including the elderly and children, and will be partners in our everyday lives. Machine translations will make our communication across languages and cultures easy and smooth.	Does it violate human dignity that an AI agent pretending to be and indistinguishable from a human being interacts with human users? Is it always required for AI agents to identify themselves as AI?	Changing relationship between humans and AI, and the emerging new sense of ethics Humans have utilized various tools and machines to make choices and decisions depending on circumstances. The advancement of AI is increasing the cases in which AI, using big data, can make accurate and quick decisions, semi-automatic operations, and statistically appropriate choices. When AI supports human choices and decisions, there are many benefits, such as improvement in accuracy and speed, and independence from human cognitive bias and prejudice. We should, however, consider the balance between human decisions and AI-based decisions. Relationships between humans and AI/machines will change gradually as AI advances, likely accompanied by the emergence of a new sense of ethics based on the evolving relationships.
Mobility-B (ride share): Ride-share taxis and buses will optimize routes based on several passengers' destinations, removing the need for passengers to wait a long time for a bus or taxi or seek a complex transit route of public buses or subways themselves. The ride share system will be useful for people living in a depopulated area and/or elderly people.	Should passengers' features (e.g., disability, social disadvantage, or gender) or personal urgency be considered in addition to service fees when their ride-share's route is optimized? If so, how should their priority and route optimization be decided?	Manufacturing-B (creations): AI will produce extensive literary writings, music, and arts semi-autonomously. AI will be able to re-produce the touch of famous artists with high accuracy.	How are the originality of AI creations evaluated? Should it be stated whether a product was made using AI	Services-B (credit examination, financing): AI will improve the reliability and speed of credit examinations using various personal data, and reduce the costs and complications of financing. It will benefit both lenders and borrowers.	Do humans accept their credit scores being ranked or evaluated by AI?		How much can we accept AI affecting and modulating our emotion, affection, and faith?	Concerns about modulating emotion, faith, and behavior, and ranking or selecting by AI: Revisiting the concept of humanity AI is becoming able to support and make decisions and actions that only humans have previously been able to perform. People may have concerns and anxieties about AI's potential modulation or operation of our mind and behavior, evaluation or ranking of people by AI, and AI influencing people's emotion, affection, and faith. Ethical discussions might especially be needed if these are conducted without people's awareness. In the future, our senses of space, time, and the body will be augmented by AI, and changing concepts of human ability and emotion may interact with such augmented senses. Accordingly, the concept of humanity may be revisited taking account of these AI's potential.
Delivery of customers' orders will be optimized for each customer, ensuring they can receive ordered objects at a desired time and place by autonomous vehicles and drones. Autonomous vehicles will reduce the driving load of delivery drivers in specific areas where this technology is available.			Does one become uncertain of or doubt one's first impression of a creation when later discovering the creation was made by AI?	Services-C (recommender system): Recommendations on various activities, issues, and events (e.g., shopping, political issues, behaviors, careers, and communications), optimized for each individual, will be provided based on AI inferences, using big data and individual data on behaviors, shopping, and affiliations.	What are optimal conditions or goals of AI recommender systems (how to balance the different goals of individuals, companies, governments, and humankind)?			Considering the value of products and actions relating to AI: Sustaining the diversity in values and future prospects It can be predicted that AI will enhance productivity quantitatively and qualitatively, and be able to produce objects that otherwise either could not be made or would require high costs and/or a long time to make. Thus, everyone will have access to such high-quality items. It might be necessary to discuss how to evaluate the values (e.g., originality, utility, and virtue) of products made and actions performed by humans, AI, and human cooperating with AI, together with how those values are accepted in society. Cooperation between humans and AI can lead to augmentation of human ability, and will be a basis of a new sense of values. We should consider individuals' differences in values and future prospects, and sustain various choices and the diversity of values.
			Is it acceptable for AI to make a large quantity of arts or creations affecting humans' impressions and emotions?		Is it acceptable that customer profiling is conducted without users' awareness, and users are classified or ranked without their awareness?			
					Though users are convinced that they behave according to their own free will, AI recommender systems would actually influence their behaviors. It should be discussed ethically.			

Legal Issues

Mobility		Manufacturing		Personal services (including medical care and finance)		Conversation/Communication		Common Issues
Mobility-A (autonomous vehicle): Autonomous vehicles will execute accelerating, braking, and steering instead of a human driver, using vehicles' sensors such as cameras, radars, and GPSs with traffic information from external networks, enabling them to drive on highways or jammed roads reducing the driver's workload. Autonomous vehicles will reduce the psychological load and physical workload of elderly people who have concerns regarding dynamic vision and quick action through AI support. Even when a driver becomes unable to control a car due to an accident, the autonomous vehicle can safely control and park the car.	Who is responsible for the accidents that occur during automated driving?	Manufacturing-A (automated factory): Robot arms with AI will be able to handle any objects, regardless of their shapes and orientations, without complicated programing. Accordingly, manufacturing of a wide variety of products in small quantities and for various needs will be realized with low costs. Factory robots will learn specialist skills, enabling them to perform specialist skills and contribute to other workers learning specialists' implicit skills. Power-assisting robotic suites (exoskeleton) will reduce the physical workloads of workers.	Should we place responsibility on the user of a myoelectric-controlled powered exoskeleton for the accidents caused by its malfunction, based on the idea that the myoelectric signal reflects the user's will?	Services-A (medical care, diagnosis): Predicting health status and doctors' diagnoses will be supported by AI using daily-life data and/or DNA sequences. Based on these, how to change one's lifestyle, how to prevent diseases, and medical care can be proposed optimally for individuals.	Who is responsible for erroneous diagnoses?	Conversation-A (conversation agent): Conversation agents speaking and understanding users' native language will be useful for all people, including the elderly and children, and will be partners in our everyday lives. Machine translations will make our communication across languages and cultures easy and smooth.	Who is responsible for the accidents and damage caused by misinterpretation by conversation agents and machine translation systems?	**Clarifying the locus of responsibility for accidents and other problems caused by AI: Considering the risks of using and not using AI** It is anticipated that users and businesses could benefit from AI more easily by clearly determining the locus of responsibility for risks, accidents, and rights infringement – in addition to the benefits and achievements – caused by AI. For human society to accept and benefit from AI technologies, it could be useful to clarify the locus of responsibility according to the levels of technological advancement (e.g., the levels 0 to 4 for the automated driving technology) and to deal with uncertain, probabilistic risks through insurance. Clarifying the locus of responsibility is also important for preventing businesses from becoming intimidated by or overreacting to reputation risks. It is important to consider not only the risks from using AI but also the risks of losing opportunities and credibility by not using AI.
	Is it necessary to reinterpret/revise the Road Traffic Act to deal with drivers who remotely control vehicles?		Who is responsible for the accidents caused by autonomous robots?		Is it necessary to review whether the diagnosis by AI should be regarded as medical practice, and to review the relationship between disease naming and treatment actions (e.g., prescribing drugs)?		How can we protect personal information when collecting all the data of conversations and user logs to improve systems using machine learning?	**Balancing the benefits from AI exploiting big data with privacy information protection** The ability to exploit big data would make AI more useful. However, there would be a trade-off relationship between its usefulness and personal information protection (privacy issues). It is necessary to consider appropriate institutional frameworks (laws, guidelines, and contracts) to avoid the chilling effects of fearing privacy invasion and balancing the usefulness with privacy issues. We might need to clarify Japan's positions on access to personal information, data portability, rights to be forgotten, and related security issues. It is anticipated that the government considers the utilization of AI for government services to embody the above positions.
	How can we guarantee privacy when we try to improve security by using surveillance cameras, etc.? How can we assure the options for protecting our privacy rights (i.e., the options on how much personal information we must disclose, which could vary between individuals)?	Manufacturing-B (creations): AI will produce extensive literary writings, music, and arts semi-autonomously. AI will be able to re-produce the touch of famous artists with high accuracy.	How should we treat copyright and other intellectual property rights in AI creations (e.g., granting rights depending on how much AI is exploited for the creation, and claiming rights or incentives for AI developers)?	Services-B (credit examination, financing): AI will improve the reliability and speed of credit examinations using various personal data, and reduce the costs and complications of financing. It will benefit both lenders and borrowers.	Do we need any special restrictions on the information used for AI credit examinations?		How can we protect copyright and other rights in the creation resulting from conversations and interaction between conversation agents and humans?	**Considering the rights and incentives for the creation by AI** It is necessary to consider who retains the property rights to the creation and calculation results produced by AI or the collaboration between AI and humans (i.e., shares of contributions), given that the exploitation of AI will easily create high-value products. Furthermore, to facilitate the development and utilization of AI, it is expected that people will find an appropriate method of assignment of rights (incentives) to AI developers, users, and data owners by means of appropriate contracts and guidelines on a case-by-case basis.
Mobility-B (ride share): Ride-share taxis and buses will optimize routes based on several passengers' destinations, removing the need for passengers to wait a long time for a bus or taxi or seek a complex transit route of public buses or subways themselves. The ride share system will be useful for people living in a depopulated area and/or elderly people.	How can we protect the personal information of fellow passengers?		Is it necessary to review labor and tax laws, which assume a laborer belongs to a company, if more people work as sole proprietors?	Services-C (recommender system): Recommendations on various activities, issues, and events (e.g., shopping, political issues, behaviors, careers, and communications), optimized for each individual, will be provided based on AI inferences, using big data and individual data on behaviors, shopping, and affiliations.	We need to protect personal data that is used for profiling personal information and the resulting profiles.			**Possible necessity of rethinking the concept of law itself** We need to continuously discuss whether the existing laws (on transportation, business, pharmacy, labor, etc.) can deal with the change in jobs and employment caused by AI, whether we need to revise existing laws or introduce new legislation, or whether we need to fundamentally reconsider the concept of law itself.
	Is it necessary to reinterpret/revise road transport laws?		How can we guarantee the intellectual property rights of original creations by humans if AI can fully replicate the creations?					
Mobility-C (autonomous logistica): Delivery of customers' orders will be optimized for each customer, ensuring they can receive ordered objects at a desired time and place. Autonomous vehicles will reduce the driving load of delivery drivers in specific areas where this technology is available.	How can we protect personal information, such as when the receiver is absent, whether they live alone, and whether they are elderly?							

Economic Issues

Mobility		Manufacturing		Personal services (including medical care and finance)		Conversation/Communication		Common Issues
Mobility-A (autonomous vehicle): Autonomous vehicles will execute accelerating, braking, and steering instead of a human driver, using vehicles' sensors such as cameras, radars, and GPSs with traffic information from external networks, enabling them to drive on highways or jammed roads reducing the driver's workload. Autonomous vehicles will reduce the psychological load and physical workload of elderly people who have concerns regarding dynamic vision and quick action through AI support. Even when a driver becomes unable to control a car due to an accident, the autonomous vehicle can safely control and park the car.	Is it necessary for manufacturers to manage the product liability risks and possibilities of accidents?	Manufacturing-A (automated factory): Robot arms with AI will be able to handle any objects, regardless of their shapes and orientations, without complicated programing. Accordingly, manufacturing of a wide variety of products in small quantities and for various needs will be realized with low costs. Factory robots will learn specialist skills, enabling them to perform specialist skills and contribute to other workers learning specialists' implicit skills. Power-assisting robotic suites (exoskeleton) will reduce the physical workloads of workers.	Business decision-making might be redesigned to enable the utilization of new AI algorithms (including the adaptation of AI to business decisions) and high-mix, low-volume production.	Services-A (medical care, diagnosis): Predicting health status and doctors' diagnoses will be supported by AI using daily-life data and/or DNA sequences. Based on these, how to change one's lifestyle, how to prevent diseases, and medical care can be proposed optimally for individuals.	Will the advancement of personal profiling that exploits information on life patterns, genes, family members, and other matters change the industrial structure as it sophisticates the prediction of possible diseases, thus diminishing the need for insurance?	Conversation-A (conversation agent): Conversation agents speaking and understanding users' native language will be useful for all people, including the elderly and children, and will be partners in our everyday lives. Machine translations will make our communication across languages and cultures easy and smooth.	For jobs in which workers talk and communicate based on rules and case examples (e.g., customer support, question answering, and legal advice), human workers might be replaced by AI and the number of required workers decreases, even in the fields where sophisticated skills have been required.	It is possible that the comparative advantage of AI will drastically change the power relationships in business, just as the small number of companies that successfully exploited big data on the Internet gained extensive power in the information society. It is also anticipated that many companies can reduce business costs and improve their business impetus, since AI requires less labor power to run companies.
	Can the current insurance system, which determines premiums based on drivers' attributes and experience, be viable if the vehicle software is more responsible for accidents than human drivers?		Do we have to consider the system (e.g., basic income) that distributes AI wealth fairly and broadly (since an automated factory would reduce labor hours and workers, though it can solve staffing shortages as it improves productivity due to the need for fewer labor hours and workers)?	Services-B (credit examination, financing): AI will improve the reliability and speed of credit examinations using various personal data, and reduce the costs and complications of financing. It will benefit both lenders and borrowers.	AI-based credit and finance-related personal services will accelerate complicated credit examinations. However, those services may reduce the number of workers for credit examination, leading to the conversion of work positions. Thus, the credit and finance-related workers might be urged to acquire new skills.			Changes in the ways people work caused by AI: For individual workers It is expected that employees will be freed from tedious tasks and required to focus on more creative tasks, since AI will be able to do the current jobs and tasks that humans do. To perform such creative tasks, workers will have to acquire abilities to move to other jobs to fully use their talents, to do creative things, and to exploit AI. It is also expected that the number of new businesses will increase and more people will work on their own account.
Mobility-B (ride share): Ride-share taxis and buses will optimize routes based on several passengers' destinations, removing the need for passengers to wait a long time for a bus or taxi or seek a complex transit route of public buses or subways themselves. The ride share system will be useful for people living in a depopulated area and/or elderly people.	What insurance will be available and who should pay for it?	Manufacturing-B (creations): AI will produce extensive literary writings, music, and arts semi-autonomously. AI will be able to re-produce the touch of famous artists with high accuracy.	AI may facilitate creation of small-scale businesses by individuals because AI supports human creations with low costs. If there are barriers to prevent such economic opportunities (e.g. social institutions and cultural framework), the government should take appropriate actions to remove them. More people might be unconstrained by time and location when they work (e.g., teleworking).	Services-C (recommender system): Recommendations on various activities, issues, and events (e.g., shopping, political issues, behaviors, careers, and communications), optimized for each individual, will be provided based on AI inferences, using big data and individual data on behaviors, shopping, and affiliations.	It is anticipated that recommender systems will affect some job categories, though the systems are expected to be exploited in many fields and facilitate economic growth, which will increase employment. Will the adaptation of recommender systems to office administration, for the purpose of suggesting the best action, reduce the need for secretaries except for service and communication-related tasks, though also lowering business costs?			Change in employment systems and companies due to the utilization of AI: For companies It is anticipated that the utilization of AI will reduce tedious, prolonged, and exhausting jobs and increase high-value jobs and the freedom of people to work without belonging to companies. These transformations will require companies to reconsider their way of decision-making and staff (re)assignment, taking advantage of the flexibility of working that are unconstrained by time and space, e.g., teleworking.
	Will taxi drivers, as skilled workers, lose their jobs or suffer an income-cut?							Policy for facilitating the utilization of AI: For the government At government level, it is necessary to formulate policies that provide opportunities for people to learn abilities for labor moving, in order to facilitate economic growth by AI and ensure a variety of ways of working that are suitable for individuals. In addition, it might be important to consider the necessity of implementing appropriate macroeconomic policies and safety nets. It is necessary to consider how to fairly distribute the profits and benefits of productivity improvements, economic revitalization, and predictability attributable to AI.
Delivery of customers' orders will be optimized for each customer, ensuring they can receive ordered objects at a desired time and place by autonomous vehicles and drones. Autonomous vehicles will reduce the driving load of delivery drivers in specific areas where this technology is available.	Is autonomous logistics unprofitable if it costs too much due to serving few customers in underpopulated areas?							
	Will autonomous logistics steal truck drivers' jobs or their income? Will it automate delivery planning (which requires skills, though autonomous logistics solves the problem of redelivery due to the receivers' absence, which increases logistics costs)?							

Social Issues

Mobility		Manufacturing		Personal services (including medical care and finance)		Conversation/Communication		Common Issues
Mobility-A (autonomous vehicle): Autonomous vehicles will execute accelerating, braking, and steering instead of a human driver, using vehicles' sensors such as cameras, radars, and GPSs with traffic information from external networks, enabling them to drive on highways or jammed roads reducing the driver's workload. Autonomous vehicles will reduce the psychological load and physical workload of elderly people who have concerns regarding dynamic vision and quick action through AI support. Even when a driver becomes unable to control a car due to an accident, the autonomous vehicle can safely control and park the car.	Should the elderly be forced to use autonomous vehicles by reason of efficiency and safety? Can the freedom of choice on how to move be preserved? Should the variety of options, with some people wanting to use autonomous vehicle while others want to drive themselves, be guaranteed?	Manufacturing-A (automated factory): Robot arms with AI will be able to handle any objects, regardless of their shapes and orientations, without complicated programing. Accordingly, manufacturing of a wide variety of products in small quantities and for various needs will be realized with low costs. Factory robots will learn specialist skills, enabling them to perform specialist skills and contribute to other workers learning specialists' implicit skills. Power-assisting robotic suites (exoskeleton) will reduce the physical workloads of workers.	There are concerns about the market being monopolized by a few large companies, depending on the disparity between companies that can and those that cannot utilize big data and/or AI	Services-A (medical care, diagnosis): Predicting health status and doctors' diagnoses will be supported by AI using daily-life data and/or DNA sequences. Based on these, how to change one's lifestyle, how to prevent diseases, and medical care can be proposed optimally for individuals.	Consensus could be necessary to determine how far we can estimate health status and future disease in detail. Is it necessary to establish a system for allowing individuals to determine?	Conversation-A (conversation agent): Conversation agents speaking and understanding users' native language will be useful for all people, including the elderly and children, and will be partners in our everyday lives. Machine translations will make our communication across languages and cultures easy and smooth.	How extensively can AI be involved in human communication?	**Freedom to use (or not use) AI: Right to be forgotten** The social benefits from AI are huge, as the realization of social security and safety and improvement of productivity counters labor shortages, a decreasing birthrate, and an aging population. However, like many other tools and technologies, AI's utilization cannot be socially enforced, even if it has social benefits. It may be necessary to take into consideration ensuring freedom to use AI, based on individuals' faith, and avoiding social conflict between users and non-users of AI. For these purposes, it is necessary to provide forums where persons with different visions and ideas, including experts, can establish dialogues continuously. Furthermore, for persons who submit personal data to benefit from AI to be able to delete all of that data once they decide to stop using a service, it might be necessary to consider establishing opt-in / opt-out methods and institutions.
		Manufacturing-B (creations): AI will produce extensive literary writings, music, and arts semi-autonomously. AI will be able to re-produce the touch of famous artists with high accuracy.	Excessive confidence in AI, praise for AI creation, rejection / aversion, and its possible social confrontation.		Is there any possibility of discrimination due to disease susceptibility or health conditions?		Will conflict occur where, in a conversation between two (or more people), one person wishes to communicate using a conversation agent and the other does not?	**AI divide: Unbalanced burden of social costs relative to AI** To maximize benefits from AI, in addition to appropriate knowledge on AI itself, users need digital goods and services literacy and knowledge of data privacy. However, if some people cannot acquire or maintain this knowledge and literacy, it might a factor to cause the so-called "AI divide". For example, "ride share" backed by AI could offer a new means of transport at low cost comparative to taxi, therefore supportive of socially weak people. However access to these services require a minimum familiarity with digital devises, so that these people without this literacy may be excluded from benefit of ride share services. Therefore, it is necessary to take into consideration and make policies to avoid generating an imbalanced social cost burden and a new differential caused by literacy, knowledge, and assets.
Mobility-B (ride share): Ride-share taxis and buses will optimize routes based on several passengers' destinations, removing the need for passengers to wait a long time for a bus or taxi or seek a complex transit route of public buses or subways themselves. The ride share system will be useful for people living in a depopulated area and/or elderly people.	There might be a possibility of a digital (or AI) divide, for example, as socially weak people in traffic, such as the elderly, come to live in a society where a smartphone or the internet is a prerequisite for using services.				While young people with literacy and assets will be able to utilize AI, and highly educated and rich people can become healthier by utilizing disease prevention, socially weak people who cannot use AI are expected to become less healthy. This may mean that economic disparity will increase social disparity through AI.		There is a possibility of excessive empathy with and dependence on the conversation agent (addiction).	**New social pathology, conflict, and dependence on AI** With increasing opportunities to use AI in social contexts, there is a possibility of generating social pathology and new social problems, such as excessive rejection, overconfidence, and dependence on AI. It is, therefore, assumed necessary to provide accurate information and the opportunity for dialogue, and for training.
	Will conventional taxis become relatively expensive as the number of their users decreases, and will the imbalance of the movement cost between people who can use ride share and those who cannot increase? It might be hard to use for the socially weak people, who should primarily benefit from AI.			Services-B (credit examination, financing): AI will improve the reliability and speed of credit examinations using various personal data, and reduce the costs and complications of financing. It will benefit both lenders and borrowers.	Will a person who does not want to provide personal information be denied access to credit screening or face a fall in their credit rating? How and what extent to assign decisions of the credit examination to humans and AI?			
Delivery of customers' orders will be optimized for each customer, ensuring they can receive ordered objects at a desired time and place by autonomous vehicles and drones. Autonomous vehicles will reduce the driving load of delivery drivers in specific areas where this technology is available.				Services-C (recommender system): Recommendations on various activities, issues, and events (e.g., shopping, political issues, behaviors, careers, and communications), optimized for each individual, will be provided based on AI inferences, using big data and individual data on behaviors, shopping, and affiliations.	Will opportunities to encounter new information be reduced as surrounded by convenient services such as the personal optimization based on AI?			
					Care should be taken to avoid the possibility of discrimination based on profile results.			

Educational Issues

Mobility		Manufacturing		Personal services (including medical care and finance)		Conversation/Communication		Common Issues
Mobility-A (autonomous vehicle): Autonomous vehicles will execute accelerating, braking, and steering instead of a human driver, using vehicles' sensors such as cameras, radars, and GPSs with traffic information from external networks, enabling them to drive on highways or jammed roads reducing the driver's workload. Autonomous vehicles will reduce the psychological load and physical workload of elderly people who have concerns regarding dynamic vision and quick action through AI support. Even when a driver becomes unable to control a car due to an accident, the autonomous vehicle can safely control and park the car.	Human drivers should acquire ability to shape appropriate decision making on choosing human control and AI control accordingly, and cooperating with an autonomous control system.	Manufacturing-A (automated factory): Robot arms with AI will be able to handle any objects, regardless of their shapes and orientations, without complicated programing. Accordingly, manufacturing of a wide variety of products in small quantities and for various needs will be realized with low costs. Factory robots will learn specialist skills, enabling them to perform specialist skills and contribute to other workers learning specialists' implicit skills. Power-assisting robotic suites (exoskeleton) will reduce the physical workloads of workers.	It might be required for factory workers to acquire literacy to collaborate with autonomous machines or AI	Services-A (medical care, diagnosis): Predicting health status and doctors' diagnoses will be supported by AI using daily-life data and/or DNA sequences. Based on these, how to change one's lifestyle, how to prevent diseases, and medical care can be proposed optimally for individuals.	It is important to cultivate (potential) patients' abilities to understand diagnoses and predicted diseases, and actively use them to enhance their own quality of life.	Conversation-A (conversation agent): Conversation agents speaking and understanding users' native language will be useful for all people, including the elderly and children, and will be partners in our everyday lives. Machine translations will make our communication across languages and cultures easy and smooth.	Abilities to communicate and lead conversations with others may be diminished.	**Cultivating individuals' ability to utilize AI** When new tools and technologies appear, humans first train on how to use them, and then, ultimately, benefit. For AI, we should learn how to identify responsibilities and acquire literacy and skills to know how and in what ways AI makes choices or judgments and operates. In summary, it is necessary to cultivate users' ability to utilize AI by themselves and to perform creative activities collaborating with AI.
	It may be necessary to cultivate literacy for appropriate reliance on AI (preventing over-reliance or unfounded rejection).		It is necessary to cultivate human resources who have advanced skills or creative abilities that robots cannot perform?	Services-B (credit examination, financing): AI will improve the reliability and speed of credit examinations using various personal data, and reduce the costs and complications of financing. It will benefit both lenders and borrowers.	It is important to cultivate lenders' abilities to judge financing utilizing AI credit examinations, considering the circumstances, type of business, and risks by themselves.		Individual differences in communication ability might be enlarged.	**Cultivating human abilities that AI cannot perform** We should investigate what can be performed efficiently by AI and what cannot, then discuss the reform of education curricula based on this evidence to cultivate human abilities that AI cannot perform. Education for children is especially urgent because it takes time and AI development is so fast. It is important to consider what abilities should be still learned by humans even though the activities enabled by those abilities can be performed instead by AI.
Mobility-B (ride share): Ride-share taxis and buses will optimize routes based on several passengers' destinations, removing the need for passengers to wait a long time for a bus or taxi or seek a complex transit route of public buses or subways themselves. The ride share system will be useful for people living in a depopulated area and/or elderly people.			While the production and tradition of advanced skills and traditional crafts will be easy by AI and robots, it might lead to decreased demand for human workers in these fields. Is it necessary to provide industry protection and educational environments to preserve cultures and maintain diversity?	Services-C (recommender system): Recommendations on various activities, issues, and events (e.g., shopping, political issues, behaviors, careers, and communications), optimized for each individual, will be provided based on AI inferences, using big data and individual data on behaviors, shopping, and affiliations.	Ability to choose information might be diminished by the personalized recommender system. It is important to cultivate abilities to seek and obtain novel information, rather than being limited to recommended information.		Is it necessary for users to acquire literacies specific to cyber communications, such as handling flames, privacy matters, and cyber security?	**Policy actions against educational inequity** Policy making is needed to improve AI literacy and skills through school education, academic training and educational environments for self-learning. To minimize disparity on AI, policy actions against educational inequity are required.
Delivery of customers' orders will be optimized for each customer, ensuring they can receive ordered objects at a desired time and place by autonomous vehicles and drones. Autonomous vehicles will reduce the driving load of delivery drivers in specific areas where this technology is available.		Manufacturing-B (creations): AI will produce extensive literary writings, music, and arts semi-autonomously. AI will be able to re-produce the touch of famous artists with high accuracy.	It is necessary to cultivate abilities for creative production utilizing AI.				It is necessary to educate ability to assess the level of a conversation agent or a machine translation, and use them adequately in critical situations.	

Research and Developmental Issues

Mobility		Manufacturing		Personal services (including medical care and finance)		Conversation/Communication		Common Issues
Mobility-A (autonomous vehicle): Autonomous vehicles will execute accelerating, braking, and steering instead of a human driver, using vehicles' sensors such as cameras, radars, and GPSs with traffic information from external networks, enabling them to drive on highways or jammed roads reducing the driver's workload. Autonomous vehicles will reduce the psychological load and physical workload of elderly people who have concerns regarding dynamic vision and quick action through AI support. Even when a driver becomes unable to control a car due to an accident, the autonomous vehicle can safely control and park the car.	The method to deal with security risks is necessary (e.g., periodic patrol or scan AI systems, applying virus pattern file, detaching the contaminated devices from networks, or stopping automatic control promptly).	Manufacturing-A (automated factory): Robot arms with AI will be able to handle any objects, regardless of their shapes and orientations, without complicated programing. Accordingly, manufacturing of a wide variety of products in small quantities and for various needs will be realized with low costs. Factory robots will learn specialist skills, enabling them to perform specialist skills and contribute to other workers learning specialists' implicit skills. Power-assisting robotic suites (exoskeleton) will reduce the physical workloads of workers.	It is necessary to implement security to prevent robots from being directed to wrong or unintended work and being hacked from outside. Technical functions that enable us to trace the status, calculations, and outputs of AI when certain accidents occur is also to be developed.	Services-A (medical care, diagnosis): Predicting health status and doctors' diagnoses will be supported by AI using daily-life data and/or DNA sequences. Based on these, how to change one's lifestyle, how to prevent diseases, and medical care can be proposed optimally for individuals.	It is necessary to develop methods to anonymize each person's data to avoid identification from the collected data, together with techniques to protect privacy such that each person can access their own data.	Conversation-A (conversation agent): Conversation agents speaking and understanding users' native language will be useful for all people, including the elderly and children, and will be partners in our everyday lives. Machine translations will make our communication across languages and cultures easy and smooth.	Technical methods to advance AI algorithms by collecting big data while simultaneously protecting individual privacy might be necessary. Methods to monitor users' emotional and mental impacts and prevent addiction or excessive influences might also be essential.	**Ethics, Accountability, Security, and Privacy protection** It may be required for researchers and engineers to engage in R&D in AI related areas with a high level of professional ethics, while observing the ethical codes and guidelines of their academic societies and organizations, and with accountability for them. It is also necessary for scientists and engineers to establish environments to use AI with robust cyber-security and safety. It is especially essential to develop technology that enables us to choose how much individual privacy should be protected and what kind of information can be used publicly.
	The algorithm for the priority and the way to show its results are necessary to be developed.	Manufacturing-B (creations): AI will produce extensive literary writings, music, and arts semi-autonomously. AI will be able to re-produce the touch of famous artists with high accuracy.	Technical mechanisms to embed information on how much AI is used in the creation, and to assure the originality of the creation by AI should be developed.	Services-B (credit examination, financing): AI will improve the reliability and speed of credit examinations using various personal data, and reduce the costs and complications of financing. It will benefit both lenders and borrowers.	It is necessary to develop techniques to protect privacy information included in the collected data or credit examinations based thereon.			**Controllability and Transparency** It is assumed that we need to develop the technologies that enable people to control AI for its safe use, the interfaces to enable smooth transitions of controls from AI to human especially in an emergency, the technologies to explain the processes and logics of AI calculations inside AI, and the technology to embed how much AI is used in decisions or actions.
	The interfaces to switch the level of control, that is, showing the reliability of AI appropriately and promoting to switch the AI control level, are also to be developed.			Services-C (recommender system): Recommendations on various activities, issues, and events (e.g., shopping, political issues, behaviors, careers, and communications), optimized for each individual, will be provided based on AI inferences, using big data and individual data on behaviors, shopping, and affiliations.	It is necessary to develop the technical mechanism for everyone to personally set their own parameters on how much individual data can be used publicly and how much individual profiles can be estimated. Ethical attitudes may be required from researchers and engineers.			**Appropriate disclosure of information and responsible use** When spreading new technologies, we might have to invest efforts in explaining their benefits and risks fairly, and people might ultimately be required to themselves judge whether to use or not to use the technologies.
Mobility-B (ride share): Ride-share taxis and buses will optimize routes based on several passengers' destinations, removing the need for passengers to wait a long time for a bus or taxi or seek a complex transit route of public buses or subways themselves. The ride share system will be useful for people living in a depopulated area and/or elderly people.	Security mechanism to protect the passenger's privacy is necessary.							
Delivery of customers' orders will be optimized for each customer, ensuring they can receive ordered objects at a desired time and place by autonomous vehicles and drones. Autonomous vehicles will reduce the driving load of delivery drivers in specific areas where this technology is available.	Security mechanism to protect the user's privacy is necessary.							