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?	**The changing relationship between humans and AI technologies 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 technologies is increasing the cases in which they, using big data, can make accurate and quick decisions, semi-automatic operations, and statistically appropriate choices. When AI technologies support human choices and decisions, there are many benefits, such as improvement in accuracy and speed as well as independence from human cognitive bias and prejudice. However, it is important to consider the balance between human decisions and AI-based decisions depending on the situations and objects to be judged. Since relationships between humans and AI services/products/machines have gradually changed as AI technologies have advanced, it is likely that there is an emergence of a new sense of ethics based on these 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 manipulating emotion, faith, and behavior and ranking or selecting AI technologies without awareness** AI technologies are becoming able to support and make decisions and actions that only humans have previously been able to perform. Many people have concerns and anxieties about AI's potential manipulation or operation of their minds and behavior, the evaluation or ranking of people by AI technologies, and AI influencing people's emotions, affections, and faith. Ethical discussions might especially be needed if these are conducted without people's awareness. **Revisiting the concept of humanity** The future blueprints show that AI technologies augment human beings' senses and abilities regarding space, time, and the body. According to this, changing concepts of human ability and emotion are supposed. With interactions such as augmenting senses, there is an opportunity to revisit the concept of humanity by 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 technologies: The diversity in values and future prospects** The application of AI technologies has enhanced productivity quantitatively and qualitatively. AI technologies simply produce objects that otherwise either could be made only by artists/experts or would require high costs and/or a long time to generate. This indicates that everyone should have access to such high-quality items. Increasingly, new evaluation procedures have been required to observe the values (e.g., originality, utility, and virtue) of products made and actions performed by humans, AI technologies, and cooperation between both. The objective is to provide assessment results about how those values are accepted in society. Furthermore, it is also important to provide opportunities for dialogue among various people. Cooperation between humans and AI technologies can lead to the augmentation of human ability being a basis of a new sense of values. To realize this objective, continuous discussions about various choices and a diversity of values are strongly demanded based on recognition of individuals' differences in values and future prospects.
			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 and utilizing insurance: Considering the risks of using and not using AI technologies** Considering legal issues contributes to the acceleration of AI technology utilization and acceptance safely in society. Previously, statistical reports showed that most traffic accidents were caused by human errors and carelessness. Although autonomous cars enable users to expect traffic accidents to decrease and thus create a safer society, one may be concerned about who is responsible for accidents caused by autonomous car systems. Society's nearly implemented AI technologies require clear determination of the locus of responsibility for risks, accidents, rights infringement, benefits, and achievements. 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., levels 0 to 4 for automated driving technology) and to deal with uncertain, probabilistic risks through insurance . This is also important in preventing businesses from becoming intimidated by or overreacting to reputation risks. Similarly, discussion from another point of view facilitates solving legal issues, such as human society's need to discuss the risks of losing opportunities and credibility by not using AI technologies.
	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?	**Exploitation of big data with consideration of information privacy protection** The ability to exploit big data would make AI technologies more useful. It is necessary to consider appropriate institutional frameworks (laws, guidelines, and contracts) to avoid the chilling effects of privacy invasion and to balance the usefulness of AI technologies with privacy issues. A mature society has to discuss access rights to personal information data, data portability, and related security issues with international cooperation. One of the prospects supposes government services based on AI technologies to embody the above-mentioned considerations.
	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 of and incentives for creations by AI technologies** The exploitation of AI technologies encourages the easy creation of high-value products by various people, such as algorithm developers, learned-data providers, service providers, and final creators. It is necessary to consider who retains the property rights to a creation or a learned model produced by AI technologies or the collaboration between AI technologies and humans (i.e., issues of data ownership). Furthermore, to facilitate the development and utilization of AI technologies, human society is required to find an appropriate method of assignment of rights (incentives) to algorithm developers, algorithm users, and data providers 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.			**Interpretation and revision of laws and the basic science of underlying legal concepts** Continuous discussions contribute to appropriately revising laws (on transportation, business, medicine, labor, and others) with the changes to jobs and employment caused by AI technologies. There is the possibility of fundamentally reconsidering the underlying concepts of laws, such as human responsibility. For example, the existing laws do not have answers to clearly determine the locus of responsibility for an output by AI technologies or collaboration of humans and AI technologies, as AI technologies based on machine learning are socially implemented. The process of accepting AI technologies requires human society to advance as well as the technologies. Thus, discussions and social sciences are required to reconsider fundamental concepts, such as human responsibilities, that modern laws are based on.
	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 logistics): 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.	AI technologies have promoted economic and industrial activities, and they generate additional employment in new jobs such as providing data for machine learning. The comparative advantage of AI technologies drastically changes 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. Careful awareness is effective at avoiding industrial monopoly, especially with regard to its influence on society. It is also anticipated that many companies can reduce business costs and improve their business impetus, since AI technologies services/products require less labor power to operate. However, quick and appropriate actions are needed since an economically inefficient situation might occur at the transition phase when AI technologies are being implemented ethically, legally, and societally.
	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 tasks and the way people work caused by AI technologies: Individual workers** AI technologies have increasingly become capable of doing automated jobs/tasks in place of humans. Consequently, many people are required to focus on more creative activities, for instance, changing jobs. One issue that needs to be addressed is how to harmonize an individual's abilities with a creative job/task. In the case where it is difficult to change jobs, that is, human resources do not meet with job requirements, both of unemployment and a labor shortage will occur at the same time. To avoid these problems, an individual has to acquire the ability to work creatively. As new businesses increasingly implement AI technologies, work styles also change in various ways that enable more people to 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?			**Changes in employment systems and companies due to the utilization of AI technologies: Companies** AI technologies are now crucial for industries and companies if they are to compete internationally. The change of work style can be contributed to AI technologies facilitating the reduction of tedious, prolonged, and exhausting jobs/tasks and the increase high-value work, as previously mentioned. This also requires companies to reconsider their manner of decision making and staff (re)assignment in order to take advantage of work flexibility that is unconstrained by time and space, e.g., teleworking. Companies should have impetus to make quick decisions and take action when acquisition of human resources that can develop or utilize AI technologies or reassignment of labor are needed. For employee reassignment, it is effective for companies to provide education opportunities.
	Will taxi drivers, as skilled workers, lose their jobs or suffer an income-cut?							**Industrial policies facilitating AI technology utilization, and educational and employment policies enabling labor mobility: The government** At the government level, it is necessary to formulate policies that provide opportunities for people to learn abilities that enable labor mobility in order to facilitate economic growth through AI technologies and ensure that is are a variety of work styles suitable for individuals. The government also has to contribute to determining how to harmonize an individual's abilities with a creative job/task. Combining educational and employment policies is one of the effective procedures for enabling labor movement. In addition, the government has to appropriately put macroeconomic policies and safety nets in perspective. The procedures for the fair distribution of profits based on AI services/products, economic revitalization, and prevention of economic disparities should be proposed through consideration of the benefits. Since AI technologies are beneficial for Japan in confronting labor shortage, policies that enhance industrial competitiveness should be accelerated. Those policies will be more effective if users provide their opinions about companies' activities and the government's policies.
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)?							

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 technologies** AI services/products work appropriately if users understand their benefits and risks, learn how to identify responsibilities, and operate them perfectly to keep them under control. Significant issues are need to understand the advantages and limits of the current AI technologies, to perfectly utilize AI technologies, and to perform creative activities in collaboration with AI technologies.
	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.	**Enhancing essential human abilities that AI technologies cannot perform** Education policy functions according to discussions about how to efficiently reform the curriculum based on evidence that shows the limitations of technologies. For example, a deep understanding of semantics, the utilization of experience-based imagination in novel situations, the ability to identify a problem that should be solved, the ability to communicate and collaborate, and the ability to explore novel information actively and to discuss and incorporate the opinions of others are all abilities that current machine-learning AI technologies seem unable to perform, and they are expected to become more important. Enhancing these abilities differentiates humans from AI technologies and makes humans perform creative tasks by utilizing AI technologies, which leads to the realization of a sustainable society with high productivity and less labor. Education for children is especially urgent because it takes time, and the development of AI technologies is so rapid. It is important to consider what abilities should be still learned by humans for proper brain development even though the activities enabled by said abilities can be performed instead by AI 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.			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?	
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.	

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 technologies and people's dialogue on common social values** The social benefits from AI technologies are numerous, such as the realization of social security and safety, improvement of productivity to counter labor shortages, a decreasing birthrate, an aging population, and the facilitation of participation by various people (inclusiveness) with individually optimized AI technology supports. Thus, AI technologies are crucial to the realization of Society 5.0. However, like many other tools and technologies, AI technologies' utilization cannot be socially enforced. It may be necessary to take into consideration the need to ensure the freedom to use AI technologies, based on an individual's faith, and avoiding social conflict between users and non-users of AI technologies. AI technologies work as a part of Information Technologies (IT) or software programs, so users cannot simply confirm AI services/products by their appearance. Thus, a discussion is required about whether AI technologies should be always explicit. Furthermore, Society 5.0 demands the avoidance of social conflicts between AI services/products users and non-users. This also requires continuous dialogue among people with different visions and ideas, including experts, regarding opposing opinions in order to consider common, fundamental social values.
		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, the unbalanced burden of social costs relative to AI, and the prevention of discrimination** To maximize the benefits from AI technologies, in addition to appropriate knowledge of the AI technologies themselves, users need digital goods and services literacy and knowledge of data privacy. However, all people cannot acquire or maintain this knowledge and literacy, and it might be a causal factor in the so-called "AI divide." For example, "rideshare," backed by AI optimization technologies, could offer a new means of transport at a low cost comparative to taxis; therefore, it is supportive of socially disadvantaged people. However, access to these services require a minimum familiarity with digital devices, so those without literacy may be excluded from the benefit of rideshare services. As ridesharing becomes popular, the traditional taxi services may become expensive or diminished. Therefore, it is necessary to take this into consideration when making policies to avoid generating an imbalanced social cost burden and a new differential caused by literacy, knowledge, and assets. Potential discrimination based on the output of personal profiling by AI technologies must be prevented.
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 technologies** With increasing opportunities to use AI technologies in social contexts, there is a possibility of generating social pathology and new social problems, such as excessive rejection, overconfidence, and dependence on AI technologies. Recommendation and personal optimization by AI technologies may limit available information for individuals and increase the tendency for people to regard the limited information as universal. It is, therefore, necessary to provide accurate information and opportunities for dialogue and 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.			

Research and Development 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, and visualization** Researchers and engineers are required 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. AI technologies have features that users are hardly aware of; they use the technology yet do not know how it actually works inside the products/services. Thus, R&D is recommended regarding the appearance of AI technologies and to visualize how much AI technologies are used in decisions or actions.
	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.			**Security, privacy protection, controllability, and transparency** Scientists and engineers are required to establish environments with robust cyber-security and safety in which to use AI technologies. It is especially essential to develop technology that enables us to choose how much personal data to share, the level of individual privacy to be protected, and what kind of information can be used publicly. R&D should be conducted to develop technologies that enable people to control the safety features of AI technologies, to explain the processes and logics of calculations inside AI technologies, to provide interfaces that smoothly perform transitions of control from AI to human, especially in emergencies.
	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: Promoting the humanities, social sciences, and research collaboration** AI technologies based on machine learning produce statistically valid outputs, and they statistically benefit human society. For this paradigm to be accepted in society, scientists and engineers are required to explain it appropriately. When spreading new technologies, researchers and engineers might have to invest effort in explaining their benefits and risks fairly. To discuss the relationship between AI technologies and human society adequately and to design and realize a better future society, researchers in the humanities and social sciences should acquire up-to-date knowledge of new technologies and utilize them in their research. Scientists and engineers should collaborate with researchers in the humanities and social sciences for pursuing socially beneficial AI 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.							**Diversity of AI technologies for social diversity** While AI technologies are currently advancing in deep learning and machine learning, there are various basic theories and technologies. In the future, new theories will emerge and further promote AI technologies. The government needs to promote basic sciences and create an environment that supports open science to enhance R&D in AI technology diversity. This will contribute to the advancement, robustness, and safety of AI technologies. Such technological diversity seems suited for social diversity.
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.							