

Part I How AI Will Transform Science, Technology, and Innovation

How AI Will Transform Science, Technology, and Innovation	2
Chapter 1 A New Era of AI	4
Section 1 What is AI?	4
Section 2 Trends in AI technology	4
Section 3 Technical factors that brought about the dramatic progress of generative AI technology and the direction of next-generation technology	8
Chapter 2 AI R&D in Japan	13
Section 1 History of AI R&D and recent initiatives in Japan	13
Section 2 R&D on generative AI in Japan	16
Section 3 Development and utilization of computing resources and data resources for the development of foundation models	20
Section 4 Measures and R&D for ensuring AI safety	23
Section 5 Development of AI human resources	25
Chapter 3 Global trends in AI-related R&D	29
Section 1 AI-related R&D strategies in major countries/regions	31
1-1. United States	31
1-2. United Kingdom	34
1-3. European Union (EU)	37
1-4. Germany	38
1-5. France	39
1-6. Italy	39
1-7. Canada	40
1-8. People's Republic of China (China)	41
1-9. Singapore	41
Section 2 Multilateral collaborations and cooperation regarding AI	42
Chapter 4 Transformation of Science by the Use of AI	47
Section 1 Use of advanced AI in diverse scientific fields (AI for Science)	49
1-1. Improving scientific data and extracting information by using AI	49
1-2. Increasing the sophistication and speed of simulations using AI	50
1-3. Realtime prediction and control by using AI	53
1-4. Generation and inference of scientific hypotheses using AI	53
1-5. Autonomous experiments and laboratories using AI	54
Section 2 Development of foundation models and algorithms for further use of next-generation AI	58
Section 3 Issues and attempts relating to AI for Science	60
Chapter 5 Impact of Advanced AI on Society	63
Conclusion	69

Figures and Tables

Figure 1-1-1/Overview of artificial intelligence and big data technologies (time series)	5
Figure 1-1-2/Conceptual diagram of a foundation model.....	7
Figure 1-1-3/Mechanism of conversational generative AI.....	8
Figure 1-1-4/Scaling law.....	9
Table 1-1-5/Major foundation models and the number of parameters.....	11
Figure 1-1-6/Trends in the scale of generative AI.....	11
Table 1-1-7/Explanation of terms	12
Figure 1-2-1/R&D expenditures by research sector in the AI field.....	13
Figure 1-2-2/tsuzumi collaborating with a robot.....	18
Table 1-2-3/ List of corporations, etc. selected for the “Research and Development Project of the Enhanced Infrastructures for Post-5G Information and Communication Systems”	19
Figure 1-2-4/“TSUBAME4.0,” the latest supercomputer of the Global Scientific Information and Computing Center, Tokyo Institute of Technology	20
Figure 1-2-5/Appearance of the ABCI	20
Table 1-2-6/Proposals adopted for the Large-scale Language Model Building Support Program 2023	21
Figure 1-2-7/Facility of SAKURA internet’s data center	22
Figure 1-2-8/Facility of SoftBank’s generative AI computing platform	22
Table 1-2-9/Examples of AI human resource development programs	26
Figure 1-2-10/Students using the Jetson Nano tool kit	27
Figure 1-2-11/Students conducting an online survey of a local company regarding the DX and AI/data utilization status	27
Figure 1-3-1/Changes in the number of AI-related papers	30
Figure 1-3-2/Number of presentations at the AAAI by country	31
Table 1-3-3/NSF AI research institutes (National AI Research Institutes)	33
Figure 1-3-4/DARPA’s Automating Scientific Knowledge Extraction and Modeling (ASKEM) Program	34
Table 1-3-5/UKRI AI Centres for Doctoral Training (announced in October 2023)	35
Figure 1-3-6/Risk levels in the AI Act	38
Table 1-3-7/AI R&D policies of major countries/regions (as of the end of March 2024)	42
Figure 1-4-1/Status of papers using AI and machine learning	48
Figure 1-4-2/Prediction of structural changes in proteins	51
Figure 1-4-3/Mechanism of NeumaticAI	53
Table 1-4-4/Examples of initiatives for automated/autonomous experiments/laboratories	54
Figure 1-4-5/Autonomous materials search robot system (Digital Laboratory)	55
Figure 1-4-6/An automated experimental robot that can recognize environment, and flexibly dispense liquids to plants	55
Figure 1-4-7/ Gene cloning system and AI technology that support antibody discovery research .	56
Figure 1-4-8/History of domestic projects on AI robot driven science	57

Figure 1-4-9/Development and sharing of AI foundation models for scientific research (TRIP-AGIS)	59
Figure 1-5-1/Demand forecast by field of utilization of generative AI	63
Figure 1-5-2/Car body design using generative AI	65

Columns

Column 1-1	Definitions of AI	12
Column 1-2	Views on the AI Boom and the Future from the Forefront of AI Research	16
Column 1-3	Researcher involved in AI research	46
Column 1-4	Nobel Turing Challenge	49
Column 1-5	Moonshot Goal 3 “AI & Robots that Harmonize with Humans to Create Knowledge and Cross Its Borders”	58
Column 1-6	Education and generative AI	67
Column 1-7	Example of a column created by generative AI	68