

## AI & Robots that Harmonize with Humans to Create Knowledge and Cross Its Borders

### 1. Position in the program

This research project aims to create a world in which researchers and AI can harmonize to produce Nobel Prize-level research results by 2050. We will develop fundamental technologies to accelerate the productivity of human resources engaged in research and development, including not only scientific documents but also creative activities including patents.

Even today, research and development of AI and robots that accelerate experimental science is underway around the world. In experimental science, while conducting experiments and preparing materials based on the analysis of the experiments, a new discovery arises, a hypothesis is formulated, and the experiment is conducted again... This loop is repeated. In some cases, the hypothesis precedes the experiment, similar to the PDCA cycle (Plan-Do-Check-Act cycle) and the OODA loop (Observe-Orient-Decide-Act) loop in business. Current AI and robotics for experimental science are focused on one of these steps (Figure 1).

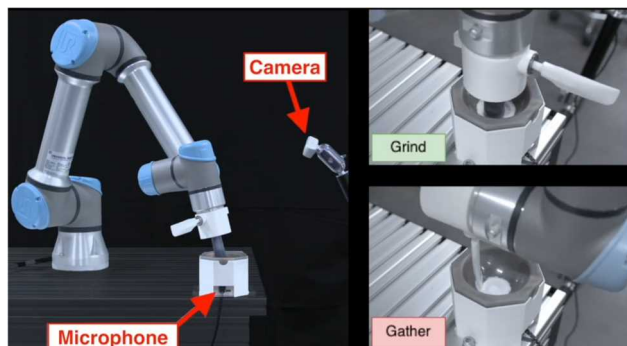


Figure 1: Powder mixing robot for materials science R&D.

This research project will develop an AI robot that will be responsible for the entire loop, enabling AI scientists to learn through the research loop and co-evolve with human researchers.

### 2. Overview of the R&D and the Challenges

Large language models such as ChatGPT are currently attracting a lot of attention. The “foundation model” including GPT (Generative Pre-trained Transformer), which is the backbone of this model, is attracting attention for its diverse uses. How did they come to be used in such a variety of ways? The reason is that it was found that if sequences of words (language model) of large text data are trained in advance and a few examples of input/output are provided for finetuning, it is possible to infer a wide variety of tasks with sufficient accuracy.

The AI scientist we are aiming for in this research project needs to be able to learn wisely based on as little experimental science data as possible and on instruction from human researchers. They also need to be able to perform a wide variety of processes in the loops described earlier.

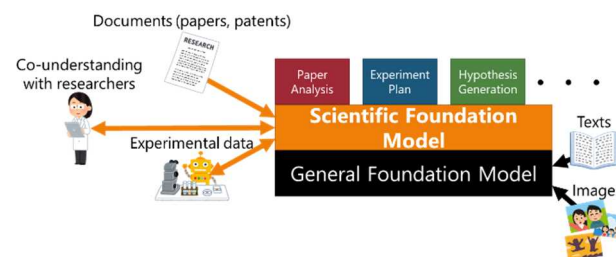


Figure 2: Overview of Scientific Foundation Model.

For this purpose, we need a foundation model for science that can learn from a wide variety of data, including scientific literature such as papers, patents, and books, experimental data, and instructions from human researchers (Figure 2).

Of course, it also needs to be able to input and output a wide variety of data (multimodal AI), including not only text but also figures, tables, and experimental data, and to interact with real-world experiments and human researchers through AI and robots. To this end, AI scientists need to present information in a way that human researchers can understand and accept; Co-understandable AI, a further development of explanatory AI, is needed.

### 3. Future plans

In this research project, by 2025, AI scientists will first learn about research conducted by human researchers through literature and experimental work, and will be able to review the literature and conduct follow-up experiments.

Then, by 2030, AI scientists themselves will be able to form hypotheses (abduction) based on experimental results and literature, plan new research claims with human researchers, design and execute experiments, analyze the results, summarize the results as documents or papers, and present them to researchers again. We plan to realize AI functions that will open up new areas of scientific knowledge.