1. Awad distinguishes between different “types” of AI. What classification scheme does the paper use and why do these types matter for scientific research?

In this paper, Awad argues that there is a large methodological diversity in AI, emphasizing that AI is not a monolithic technology. In the paper, Awad says the following are foundational models in AI: descriptive AI, predictive AI, generative AI, optimization AI, prescriptive AI, privacy-aware AI, causal AI, and explainable AI. The classification scheme for these types is based on their distinct approaches to learning, inference, and knowledge representation. This is important for scientific research, as different types of AI support different objectives in scientific research, from classification tasks to simulation.

2. Does Awad make a clear distinction between AI as a tool and AI as a scientific collaborator? If so, what are the differences and what are some examples given to support the differences? Do these examples suggest a real shift in how science is conducted, or mostly an extension of existing methods?

Awad does make a clear distinction between AI as a tool and AI as a scientific collaborator. The difference between AI as a tool and AI as a scientific collaborator is that AI as a tool is not capable of reasoning, meaning that it is only capable of assisting in speeding up the research process by performing specific tasks. This is different from AI as a scientific collaborator because it is capable of reasoning, making decisions about the experiment, analyzing and interpreting data, ultimately contributing to the experiment like a human would. AI as a scientific collaborator contributes to scientific reasoning by providing hypothesis generation, pattern recognition, and prediction. In the paper, Awad includes many examples of AI applications in scientific research, such as the use of predictive and generative AI to predict protein structures based on amino acid sequences, which used to depend on X-ray or nuclear magnetic imaging and human analysis. Another example is the use of predictive AI to predict the regulatory effects of noncoding DNA from sequence data, in order to prioritize noncoding variants that influence disease risk, demonstrating how AI is supporting the interpretation of the regulatory genome. These examples do suggest a shift in how science is conducted. Awad argues that AI has advanced past being a “tool” and is now complementing or replacing human deduction and induction with statistical and abductive inference, recognizing patterns in data and providing analytical insights. This means that the AI can generate hypotheses, design experiments, analyze data, and connect insights across different scientific disciplines, suggesting a shift from human enquiry or theory to having the AI use data to drive research.

3. What are some limitations or risks of using AI in science? How do these relate to issues such as interpretability, bias, reproducibility, or theory formation?

There are limitations and risks of using AI in science. For example, Awad notes how NLP tools have shown to perpetuate and reflect unintentional biases such as race and gender stereotypes. This is a major risk if we are using NLP in scientific or human contexts, meaning that the NLP model's outputs must be examined. Another major risk is LLMs "hallucinating", meaning that the AI produces incorrect or made-up information. We also have problems with some deep learning models or LLMs being a "black box", meaning that it produces results without transparency about how the results are derived. This is a major issue of interpretability since we will struggle with understanding the output without explanation or justification. These are just a few examples of how AI can be problematic in science. We need AI systems that allow for human interpretability, training on inclusive and diverse datasets, systems for accountability, and output validation. As Awad emphasizes in the paper, it is important that we push for these factors. Otherwise, we will be damaging scientific research rather than strengthening it.

4. According to Awad's arguments, is AI more likely to *accelerate* scientific discovery or to *reshape* the scientific method itself? Do you agree or disagree?

According to Awad's arguments, AI is more likely to reshape the scientific method itself. Awad says that AI is influencing every stage of the scientific method, such as organizing complex datasets, enhancing planning and preparation, and generating new paths to discovery. AI is also changing the way that scientific knowledge is created and validated, as advanced systems support hypothesis generation, causal reasoning, and experimental design, meaning that there is less need for human input. I agree with this viewpoint because of the examples that Awad presented in the paper. With less need for human input, or even situations without human input, the scientific method has been transformed in a way in which the AI is driving the experiment. The scientific method no longer relies on humans theorizing. Instead, AI can make decisions and influence, or if possible, run the experiments it sees as most likely to produce meaningful scientific discovery based on its interpretation and reasoning of the data.