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SCUDEM X 2025
Problem A: It Is Raining Space Dust

A large number of small particles, referred to as Cosmic Dust, constantly fall on the earth's atmosphere. Cosmic dust has a wide variety of shapes and sizes, and it comes from a wide variety of sources. The sources of cosmic dust range from comets from outside the solar system to asteroids within the solar system. Some of the particles remain intact as they fall and reach the earth's surface. The size of the particles range from just a few molecules to over 0.1mm. The particles also have a wide range of velocities.

Cosmic dust is studied because it offers one way to gain insight into how matter is distributed. The variation in sources, size, and momentum may offer some clues into the various cycles that matter might undergo over time[1], but there is a great deal about the phenomena that is not understood. To better understand the phenomena cosmic dust is collected in many different ways including capturing in complex space missions. Our goal, here, is to explore how the particles found on the earth's surface can be used to help better understand the phenomena.

The path that cosmic dust takes to the earth's surface can be complex. The particles travel long distances. They also have to contend with the adverse effects of falling through the earth's atmosphere at high velocities. Your team is asked to examine and predict what might happen to small particles as they enter the earth's atmosphere. For this initial study you should make some assumptions to greatly simplify the situation, and the goal is to provide an initial estimate to what happens to different size particles with different velocities as they fall through the earth's atmosphere. Given your findings, is it possible to use an estimate of the distribution of particles of cosmic dust found within a given strata of the earth's surface from a certain time period and work backwards to estimate the distribution of cosmic particles that entered the earth's atmosphere at that time?

Bibliography

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Problem B: An AI Ouroboros

The problem of Artificial Intelligence (AI) model collapse has been documented and studied under ideal situations[1]. AI generated content is becoming more prevalent, and it is more likely that AI content engines will use previously generate content as the input used to train newer models. The result is a potential degradation of the quality of the new content that will be generated by new AI engines.

As AI models become more prevalent, different people will use different engines. People also tend to take the output of an AI model and edit and adapt the output to suit their own tastes. Additionally, people will continue to generate new content on their own. All of these different source materials will be publicly available and will likely be used to train new AI models.

The question you are asked to examine is what happens when multiple AI models interact in the presence of new content that is generated by people as well as content generated by other AI models? How will the new content generated be impacted? What long term patterns will emerge?

Some additional questions to address include the following: Will the quality of AI model results dramatically decline, slowly decline, or not be impacted? What is the role of multiple AI models interacting? Will the different outputs generated by different models mitigate the impact of AI model collapse?

Bibliography

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Problem C: Birds of Different Feathers

Prey animals often collect into groups and move together. The resulting groups may contain one species of animal or may include multiple species. Different reasons for why animals form such groups have been proposed including increased efficiency in foraging, better detection of predators, and other advantages. We will focus on the detection of predators in groups with multiple species[1].

One proposal for why animals collect in large groups is that different species might be able to better detect the presence of predators due to the variation in their behaviours. Is it possible to provide evidence that this is the case? You are asked to develop a mathematical model of how the animals in a group composed of different species interacts and observe their environment.

If a group is composed of different species are they more likely to detect the presence of a predator? If so, what is the importance of the number of different species? Is there a minimum number of species for there to be a non-trivial advantage? Is there an upper bound for the number of species in which additional types of animals have a smaller impact?

Bibliography

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