Assignment 4

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1 AI AND ASTRONOMY

Astronomy is a natural science that studies celestial objects and phenomena. It uses mathematics, physics, and chemistry in order to explain their origin and evolution. Objects of interest include planets, moons, stars, nebulae, galaxies, and comets. Relevant phenomena include supernova explosions, gamma ray bursts, quasars, blazars, pulsars, and cosmic microwave background radiation. More generally, astronomy studies everything that originates beyond Earth's atmosphere. Cosmology is a branch of astronomy that studies the universe as a whole.

Astronomy is one of the oldest natural sciences. The early civilizations in recorded history made methodical observations of the night sky. These include the Babylonians, Greeks, Indians, Egyptians, Chinese, Maya, and many ancient indigenous peoples of the Americas. In the past, astronomy included disciplines as diverse as astrometry, celestial navigation, observational astronomy, and the making of calendars. Nowadays, professional astronomy is often said to be the same as astrophysics.

Professional astronomy is split into observational and theoretical branches. Observational astronomy is focused on acquiring data from observations of astronomical objects. This data is then analyzed using basic principles of physics. Theoretical astronomy is oriented toward the development of computer or analytical models to describe astronomical objects and phenomena. These two fields complement each other. Theoretical astronomy seeks to explain observational results and observations are used to confirm theoretical results.

- Three ways artificial intelligence is helping us learn about the universe
- Planet hunting

There are a few ways to find a planet, but the most successful has been by studying transits. When an exoplanet passes in front of its parent star, it blocks some of the light we can see.

By observing many orbits of an exoplanet, astronomers build a picture of the dips in the light, which they can use to identify the planet's properties – such as its mass, size and distance from its star. Nasa's Kepler space telescope

employed this technique to great success by watching thousands of stars at once, keeping an eye out for the telltale dips caused by planets. Time-series analysis techniques – which analyse data as a sequential sequence with time – have been combined with a type of AI to successfully identify the signals of exoplanets with up to 96

- Gravitational waves

Time-series models aren't just great for finding exoplanets, they are also perfect for finding the signals of the most catastrophic events in the universe – mergers between black holes and neutron stars.

When these incredibly dense bodies fall inwards, they send out ripples in space-time that can be detected by measuring faint signals here on Earth. Gravitational wave detector collaborations Ligo and Virgo have identified the signals of dozens of these events, all with the help of machine learning.

By training models on simulated data of black hole mergers, the teams at Ligo and Virgo can identify potential events within moments of them happening and send out alerts to astronomers around the world to turn their telescopes in the right direction.

- The changing sky

Machine learning techniques will be used to search these next-generation surveys and highlight the important data. For example, one algorithm might be searching the images for rare events such as supernovae – dramatic explosions at the end of a star's life – and another might be on the lookout for quasars. By training computers to recognise the signals of particular astronomical phenomena, the team will be able to get the right data to the right people.