Brian Nord is an astrophysicist and AI researcher at the Fermi National Accelerator Laboratory. Nord investigates the applications of **machine learning** in astronomy, with a focus on **galaxy evolution** and **gravitational lensing**. A pioneer in the domain of cosmological survey simulation and design, Nord has spearheaded numerous collaborations, including the Deep Skies Lab.

Fermi National Accelerator Laboratory, Illinois

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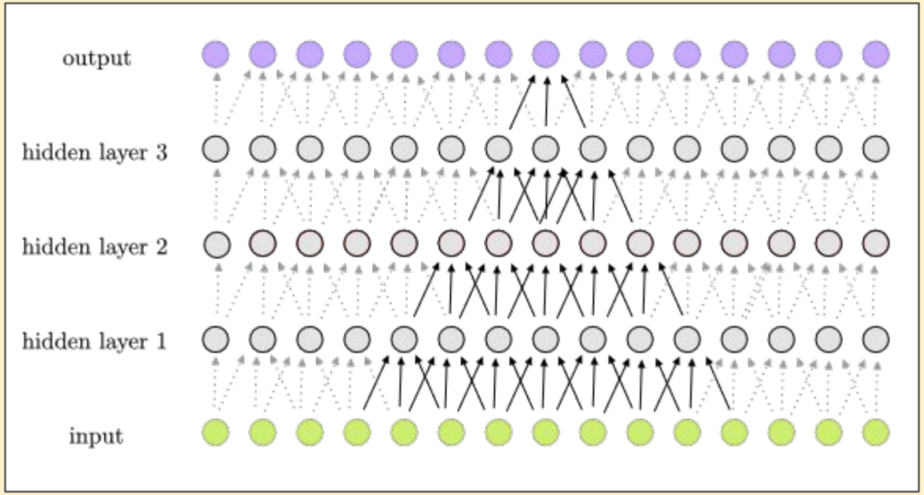
What does an AI researcher/astronomer do?

Convolutional Neural Networks (CNNs) are a type of **deep learning model** used for analyzing visual data, such as images and videos. CNNs are effective in tasks like **image classification** and **object detection**, which make them useful for processing the large, complex data sets that come from telescopes.



Example of a neural network

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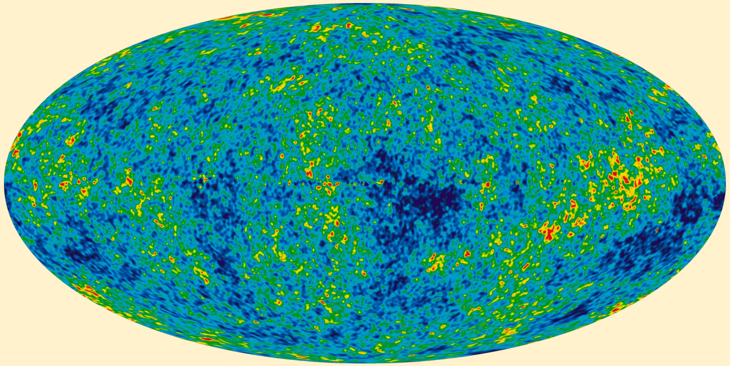
How does that impact astronomy?

Nord uses **CNNs** to separate noise from signal in maps of the **Cosmic Microwave Background (CMB)**, a bath of microwave radiation which serves as a key piece of evidence supporting the Big Bang Theory.

By training the network to identify the effects of **gravitational lensing**, Nord can improve the resolution and accuracy of large CMB maps, allowing for a better glimpse into **early-universe physics**.



Heat map of the Cosmic Microwave Background

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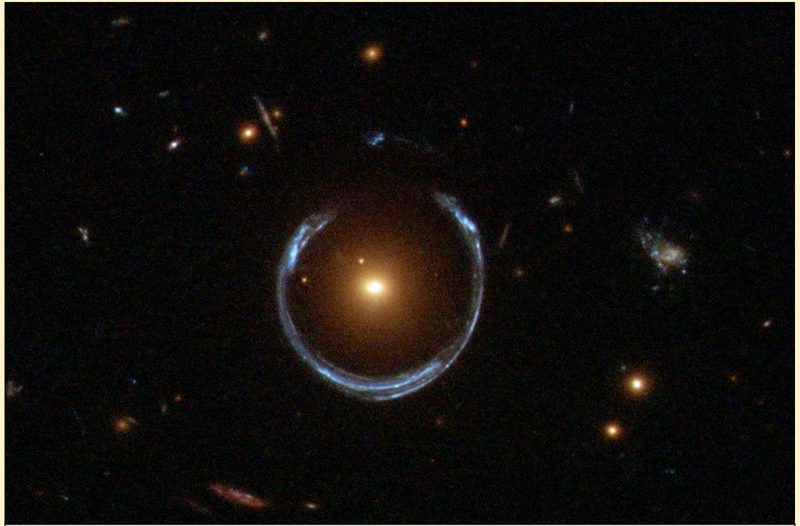
What is Gravitational Lensing?

As light travels through space, its path can be warped by the presence of massive objects, such as clusters of galaxies or stars. This warping effect is known as gravitational lensing.

Gravitational lensing can distort the apparent positions and brightness of stars and galaxies in star maps. To accurately model the universe's structure and evolution, the effect of lensing must be taken into account, or removed entirely through a process called **de-lensing**.



A gravitational lens.

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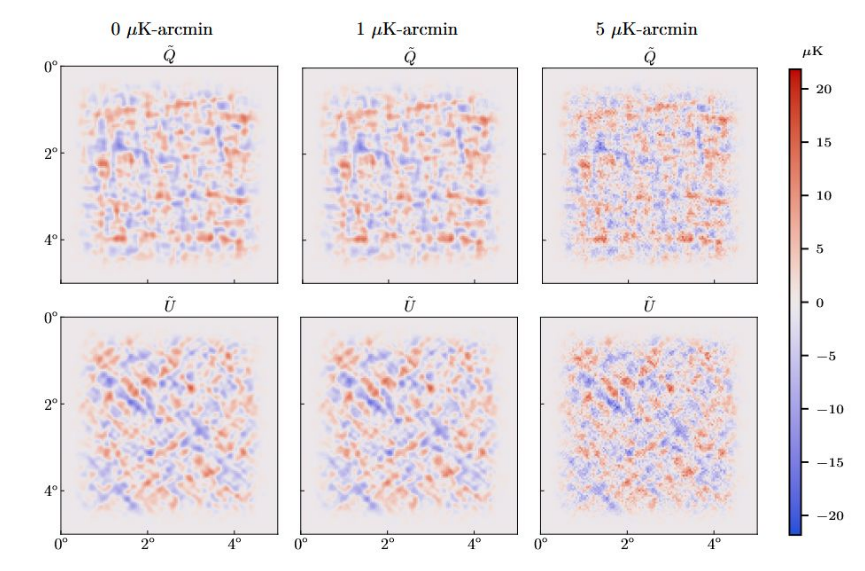
De-lensing is done using a type of feed-forward deep neural network called a **Residual U-Net** (ResUNet).

Each layer is sensitive to features at **increasingly larger scales**, allowing for both local and global information to propagate through the network.

Once the process is finished, the network can effectively map lensed CMB images to de-lensed ones and **quantify the amount of lensing** present in an image.



Simulated CMB maps with different amounts of noise

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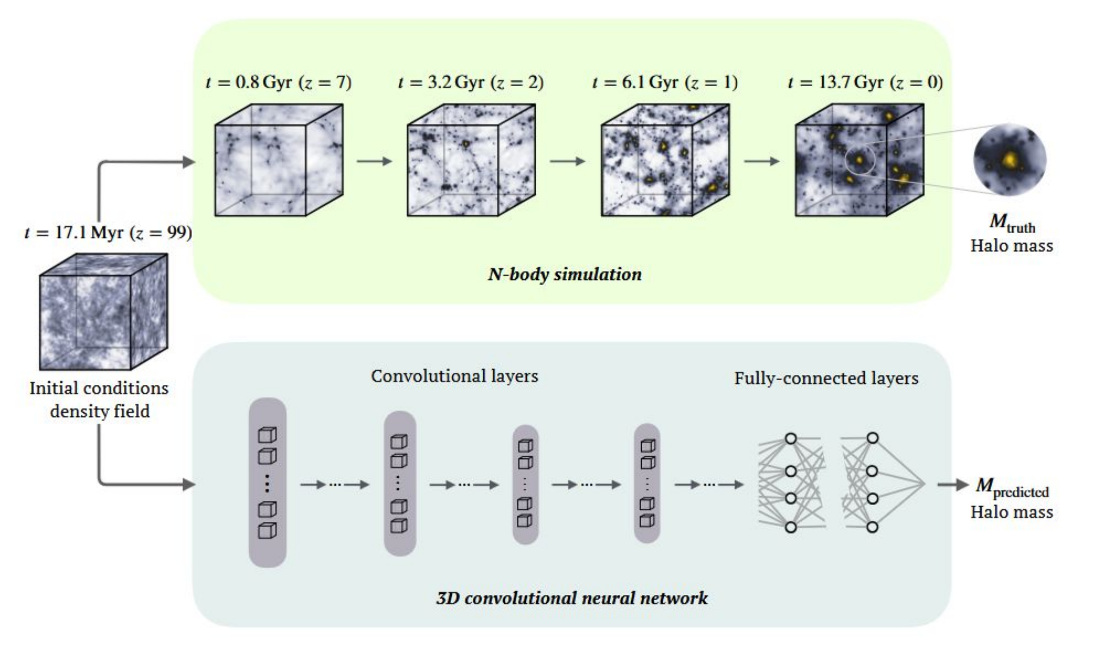
Nord's work continues to improve the sensitivity and accuracy of astronomical data analysis.

Outside of the CMB, Nord has applied novel techniques in **machine learning** to identify **redshift galaxy mergers** and **simulate cosmological structure formation.**



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Nord is an outspoken advocate for BIPOC communities in science. In 2020, Nord co-created #Strike4BlackLives, an international walk-out in protest of police brutality. He is also a co-author of ThisIsBlackLight.com, a curriculum for learning about Black experiences.

Resources:

- Brian Nord's website: http://briandnord.com/
- Wikipedia: https://en.wikipedia.org/wiki/Brian_Nord
- "Becoming Interplanetary": https://www.loc.gov/item/2021692387/

Images:

- Brian Nord, slide 1: http://briandnord.com/bio
- Fermilab, slide 1: https://50.fnal.gov/the-birth-of-fermilab/
- Neural Network, slide 2: https://en.wikipedia.org/wiki/Convolutional_neural_network#/media/File:1D_Convolutional_Neural_Network_feed_forward_example.png
- Wilkinson heat map of the CMB, slide 3: https://en.wikipedia.org/wiki/Cosmic_microwave_background#/media/File:WMAP_2012.png
- Brian Nord, slide 6: https://www.nytimes.com/2020/06/10/science/science-diversity-racism-protests.html