

PHYSICS UPDATE

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THE KEEN HEARING OF YOUNG MUSICIANS

Through varying tone, pitch, or both, the single-word remark “really” can convey surprise, skepticism, puzzlement, disapproval, or affirmation. Even when tone and pitch are not deliberately modulated, they help listeners interpret speech, especially above the din of multiple conversations. Given that tone and pitch are musical qualities, it’s perhaps not surprising that musicians have been

found to be better than nonmusicians at hearing in distracting environments. Those initial studies of what is known as the musician effect were done on adults. Now Deniz Başkent of the University of Groningen in the Netherlands and her colleagues have investigated the effect in musicians and nonmusicians ages 11–14. The participants, all native Dutch speakers, were given three types of aural test, each with an adjustable level of background. In one, the

participants were asked to identify melodic contours—that is, how a sequence of notes rises and falls in pitch. In another, they had to identify whether a nonsense word was spoken with joy, anger, relief, or sadness. And in the third, they had to recognize and repeat predesignated words in simple sentences (in Dutch) like “My neighbor has bought a new car.” Unlike the case for adults, the adolescents displayed no musician effect when identifying emotion or words. But the researchers did find a significant musician effect for melodic contours. What’s more, the advantage displayed by the young musicians persisted when the melodic contours were processed to resemble sound heard through a cochlear implant. That finding suggests that musical training could improve the hearing of children with cochlear implants. (D. Başkent et al., *J. Acoust. Soc. Am.* **143**, EL311, 2018.)

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MACHINE LEARNING SOLVES AN EXOPLANET ATMOSPHERE



For years the *Hubble Space Telescope* has captured crisp spectral images of exoplanets transiting their host stars. Because those images include light filtered through the exoplanets’ atmospheres, they contain clues about atmospheric composition. (See the Quick Study by Heather Knutson, *PHYSICS TODAY*, July 2013, page 64.) Absorption features in such spectra have produced evidence of water, carbon dioxide, methane, and even clouds in the atmospheres of extrasolar planets.

But *Hubble*’s workhorse detector for exoplanet atmosphere observations, the Wide Field Camera 3, collects light in only 13 wavelength bins. The *James Webb Space Telescope*, scheduled for a 2020 launch, will be able to resolve spectra into hundreds of bins. The abundance of data could yield far more detailed portraits of extrasolar atmospheres, but it also creates a challenge: how to decipher all that information.

Enter Kevin Heng and his coworkers at the University of Bern in Switzerland. The researchers have now demonstrated that machine learning can be used to extract atmospheric properties from even the most complicated transmission spectra. Heng and his colleagues trained their machine on tens of thousands of model spectra that were calculated analytically for atmospheres of varying temperature, cloudiness, and

composition. The machine learning algorithm plots the spectra in N -dimensional space, where N is the number of wavelength bins in each spectrum, and then identifies clusters in that multidimensional space. Model atmospheres belonging to the same cluster tend to share similar physical attributes, so when the trained machine is given a real-life spectrum to analyze, it plots the spectrum and assigns to it the physical attributes of the nearest cluster.

Reassuringly, a test-run analysis of the gas-giant planet WASP-12b yielded results similar to those of more conventional techniques. The test was implemented in 13-dimensional space, to match *Hubble*’s 13 spectral bins, but future implementations using more detailed spectra could include thousands of dimensions. (P. Márquez-Neila et al., *Nat. Astron.*, 2018, doi:10.1038/s41550-018-0504-2.)

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WARMING CLIMATE BOOSTS PLANTS’ HEIGHT AND VULNERABILITY

As Earth’s climate warms, the shrubs of alder, birch, and willow that grow on arctic tundras are becoming taller and more numerous. Although the trend yields demonstrably more food for reindeer, its other ecological implications, good and bad, are less clear. Now, a large collaboration led by Mark Olson of the National Autonomous University of Mexico has identified a potential threat: Taller plants are more vulnerable to droughts, freezes, and other climatic shocks.

As their maximum height increases, plants in regions that become warmer and wetter develop wider vessels to transport water from their roots to their leaves. Such an adaptation is shaped by the physics of capillary hydraulics. Wider vessels can harvest more water more efficiently. But the wider a vessel, the more vulnerable it is to developing flow-blocking gaps of vapor during periods of drought or freezing. If the gaps persist, the supply

of liquid water to the leaves is interrupted, and all or part of the plant dies. Plants in regions that become warmer and more prone to droughts and freezes can therefore be expected to adapt by retaining their original vessel diameters.



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To investigate the two adaptations, Olson and his team examined 1535 samples from 537 species in 19 regions, whose mean annual rainfall ranges from 10 cm to 400 cm and whose mean annual temperature ranges from 0 °C to 35 °C. They also grew plants under controlled conditions. By correlating changes in vessel diameter, stem length, and other parameters, they concluded that plants everywhere respond to a warmer climate by growing taller. If the local climate also becomes more variable, those taller plants will be at greater risk of damage, death, and displacement by shorter plants. (M. E. Olson et al., *Proc. Natl. Acad. Sci. USA*, 2018, doi:10.1073/pnas.1721728115.)

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