Spiral, barred, elliptical and irregular: Computers automatically classify galaxy shapes

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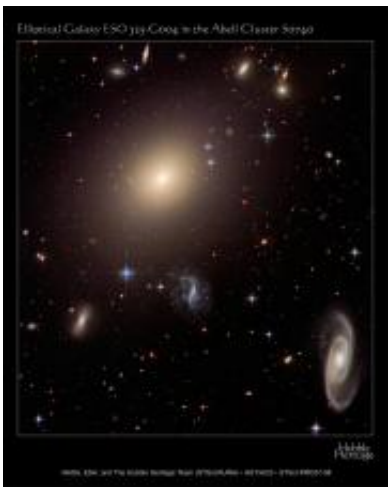

A picture of the Abell Cluster taken using the Hubble Space Telescope. The picture encapsulates the diversity in galaxy types observed in our Universe. We can see a giant elliptical galaxy at the centre of the cluster, a beautiful spiral in the bottom right-hand corner and many smaller systems displaying a wide range of shapes, sizes and colours. Credit: NASA/ESA and the Hubble Heritage Team (STScI/AURA).

(PhysOrg.com) -- Scientists at University College London and the University of Cambridge have developed machine-learning codes modelled on the human brain that can be used to classify galaxies accurately and efficiently. Remarkably, the new method is so reliable that it agrees with human classifications more than 90% of the time. The

research will appear in a paper in the journal Monthly Notices of the Royal Astronomical Society.

There are billions of galaxies in the Universe, containing anything between ten million and a trillion stars. They display a wide range of shapes, from elliptical and spiral to much more irregular systems. Large observational projects - such as the Sloan Digital Sky Survey - are mapping and imaging a vast number of galaxies. As part of the process of using these data to better understand their origin and evolution, the first step is to classify the types of galaxies within these large samples. The 250,000 members of the public participating in the Galaxy Zoo project recently classified 60 million such galaxies by eye.

Now, a team of astronomers has used Galaxy Zoo classifications to train a computer algorithm known as an artificial neural network to recognize the different galaxy types. The artificial neural network is designed to simulate a biological neural network like those found in living things. It derives complex relationships between inputs such as the shapes, sizes and colours of astrophysical objects and outputs such as their type, mimicking the analysis carried out by the human brain. This method managed to reproduce over 90% of the human classifications of galaxies.

“We were astonished that a computer could do so well” says Dr Manda Banerji from the Institute of Astronomy at the University of Cambridge who led the research, which formed part of her PhD thesis at UCL. “This kind of analysis is essential as we are now entering a new age of astronomical surveys. Next generation telescopes now under construction will image hundreds of millions and even billions of galaxies over the coming decade. The numbers are overwhelming and every image cannot viably be studied by the human eye.”

A large-scale sky survey in which the UK is playing a leading role is the

Dark Energy Survey (DES) due to commence in 2011, which is expected to image 300 million galaxies over 5 years. Another survey called the VISTA Hemisphere Survey being led by astronomers at the University of Cambridge, has just started taking data and will image galaxies over the entire southern hemisphere.

Professor Ofer Lahav, head of Astrophysics at UCL and chair of the international DES Science Committee, who supervised Banerji's thesis, commented: "While human eyes are very efficient in recognizing patterns, clever computational techniques that can reproduce this behaviour are essential as we begin to push the boundaries of our observable Universe and detect more distant galaxies. This study is an important step in that direction."

More information: The work appears in "Galaxy Zoo: Reproducing Galaxy Morphologies Via Machine Learning"; Banerji M., Lahav O., Lintott C. J., Abdalla F. B., Schawinski K., Bamford S. P., Andreescu D., Murray P., Raddick M. J., Slozar A., Szalay A., Thomas D. and Vandenberg J., Monthly Notices of the Royal Astronomical Society, in press. A pre-print of the paper can be found at arxiv.org/abs/0908.2033 .

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