The great cosmic challenge

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(PhysOrg.com) -- Today cosmologists are challenging the world to solve a compelling statistical problem, to bring us closer to understanding the nature of dark matter and energy which makes up 95 per cent of the 'missing' universe. The GRavitational lEnsing Accuracy Testing 2008 (GREAT08) PASCAL Challenge is being set by 38 scientists across 19 international institutions, with the aim of enticing other researchers to crack it by 30 April 2009.

"The GREAT08 PASCAL Challenge will help us answer the biggest question in cosmology today: what is the dark energy that seems to make up most of the universe? We realised that solving our image processing problem doesn't require knowledge of astronomy, so we're reaching out to attract novel approaches from other disciplines," says Dr Sarah Bridle, UCL Physics and Astronomy, who is leading the challenge alongside Professor John Shawe-Taylor, Director of the UCL Centre for Computational Statistics and Machine Learning.

Twenty per cent of our universe seems to be made of dark matter, an unknown substance that is fundamentally different to the material making up our known world. Seventy-five per cent of the universe appears to be made of a completely mysterious substance dubbed dark energy. One possible explanation for these surprising observations is that Einstein's law of gravity is wrong.

The method with the greatest potential to discover the nature of dark energy is gravitational lensing, in which the shapes of distant galaxies are distorted by the gravity of the intervening dark matter. "Streetlamps

appear distorted by the glass in your bathroom window and you could use the distortions to learn about the varying thickness of the glass. In the same way, we can learn about the distribution of the dark matter by looking at the shapes of distant galaxies," says Dr. Sarah Bridle. The observed galaxy images appear distorted and their shapes must be precisely disentangled from observational effects of sampling, convolution and noise. The problem being set, to measure these image distortions, involves image analysis and is ideally matched to experts in statistical inference, inverse problems and computational learning, amongst other scientific fields.

Cosmologists are gearing up for an exciting few years interpreting the results of new experiments designed to uncover the nature of dark energy, including the ground-based Dark Energy Survey (DES) in Chile and Pan-STARRS in Hawaii, and space missions by the European Space Agency (Euclid) and by NASA and the US Department of Energy (JDEM). Methods developed to solve the GREAT08 Challenge will help the analysis of this new data.

The GREAT08 Challenge contains 200 GB of simulated images, containing 30 million galaxy images. For the main competition, participants are asked to extract 5400 numbers from 170 GB of data. The competition can be accessed via the website www.great08challenge.info/ .

The GREAT08 Challenge Handbook will shortly be published in the journal Annals of Applied Statistics (AOAS).

The challenge is set by researchers from the following institutions: UCL (University College London), University of Hong Kong, Stanford Linear Accelerator Center, NASA's Jet Propulsion Laboratory, California Institute of Technology, Commissariat a l'Energie Atomique, Saclay, University of Pennsylvania, Laboratoire d'Astrophysique de Marseille,

University of Bonn, Ohio State University, Royal Observatory, University of Edinburgh, University of British Columbia, Harvard University, University of Victoria, University of Oxford, University of Leiden, University of California, Davis, Institute for Advanced Study, Princeton and Institut d'Astrophysique de Paris.

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