Big Data Astronomy

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1 Introduction

Computers have radically changed the nature of astronomy in the last half century. At one time optical astronomers had to travel to the site of an observatory in order to make observations. (One of the perk of the job used to be regular trips to exotic locations on remote mountain tops in Australia, California, Canary Islands, Chilli, Hawaii and so on - it was a hard life!)

The astronomer would prepare his photographic plates during the afternoon, and when it got dark he would mount the plates on the telescope and sit, sometimes for hours, carefully guiding the telescope so that the object in which he was interested stayed exactly on the centre of his plate. (Atmospheric refraction could distort the path of light and move the image around just too much when using a really big telescope.)

At the end of the night he would develop the images in chemical baths before going to bed for the day, hoping to get some sleep before the next night's observing session. Sometimes, after travelling halfway around the World he finds the sky cloudy, or has 'bad seeing' - turbulence in the upper atmosphere spoiling sharp images. There was always a bit of hit and miss and you could be very unlucky and find your research project delayed by months until the next session came up.

Today you are far more likely to sit at your home institution and operate the telescope remotely. That is very convenient when running observations at somewhere like Hawaii or Australia, because you are working during during the day while the telescope is in the night. In fact, you probably do not even operate your observing session at all, but having been allocated a certain amount of telescope time, you describe the observations that you require (pointing directions, exposure times, filters and so on) and it will be queued for the telescope control computer to schedule at the most convenient time. You do not need to worry about you allocated slot turning clouding - your turn in the queue will come up at a non-cloudy time.

All the sensors on very nearly all modern telescope are now electronic. Photographic plates are rarely used at all (though there are one or two roles in which they are still important). Modern charge-coupled-devices (CCDs) are much more sensitive and have the advantage that the images are directly passed to a computer and can be immediately downloaded by the observer shortly after the exposure has been completed. They are also designed to stay permanently fixed to the telescope and be used in the same way by every observer. (In contrast to the old days, when observers might bring exotic and temperamental instruments to the telescope which only they knew how to operate.) It is all very much more convenient and efficient - but perhaps not the romantic image of the astronomer sitting alone on his telescope. (These days only the specialist technical staff associated with the observatory work at the telescope dome while observations are going on.)

Those of you who have used the Faulkes Telescopes will recognise this type of process.

In fact, the process has gone much further and there are now completely robotic telescopes that scan the sky automatically performing large observing programs that might, for example, have as their purpose the discovery of new supernova events or the tracking of previously unknown asteroids. They record thousands of images each night and each is compared automatically with previous stored images in order to look for any changes. Human astronomers become directly involve only when alerted to an unusual event.

Much of the data they record is quickly made available in databases accessible to the public (though it is mostly used by astronomers at universities all around the World). Many professional research programmes rely on searching vast amounts of such on-line data: astronomy was one of the first sciences to really exploit the era of 'big data'.

This document will list research resources available to the public as I identify them.

2 The Sloan Digital Sky Survey

The Sloan Digital Sky Survey [2] is based around a 2.5m diameter robotic telescope that automatically scans the night sky, recording images of everything that it sees. Images of virtually the whole sky visible from the Apache Point observatory are now available in multiple colour bands, and most are accessible to the public via the web site.

3 HiSPARC

The HiSPARC project [1] puts cosmic ray detectors at a network of high schools, mainly in Holland but also a number in the UK. Cosmic ray showers trigger the recording of an "event" which is transmitted to a central database from which it can be downloade via the web. See the separate section of HiSPARC documents for more details.

References

[1] HiSPARC Project. http://www.hisparc.nl/en/.

[2] Sloan Digital Sky Survey web site. http://www.sdss.org.