

# Connected computing

BY BOB RIDDLE

Students can partake in scientific research through *distributed computing*, where the computing for a research project is done on a network of computers in different locations. Some distributed computing projects help search for life beyond Earth by analyzing data gathered by a radio telescope while others review photometric measurements gathered by observatories to catalog the physical characteristics of asteroids. A distributed computing project harnesses the power of many home or school computers to process data more quickly than usual.

## Getting started

Participants in a distributed computing project must install the computer program BOINC (Berkeley Open Infrastructure for Network Computing), which manages data transferring and processing (see Resources). BOINC can be downloaded on a PC, Mac, Linux, and Android. After it has been installed, you can choose the distributed com-

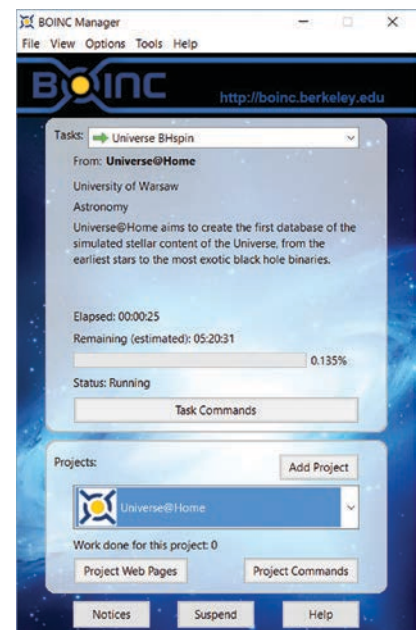
puting project that interests you and set up a username and password. Once connected to the project website, you will need to enter your zip code and then join a team, create a team, or participate as an individual. Subsequently, the BOINC manager program will transfer data from the project and the computer will begin processing (Figure 1). At this point, students could form teams to compete for the most work completed within a predetermined time frame.

Typically, the computer performs data processing when it is not in use, much in the way that a screensaver turns on after a period of inactivity. To use the Android app, the cell phone has to be both plugged in and at greater than a 90% battery charge, on a WiFi network, and not in use. There is very little interaction with the computer program other than perhaps watching the screensaver displays, some of which show graphics illustrating how the program analyzes the data.

The data processing on a smartphone occurs whenever the

phone is idle. When the phone's owner needs to use it for some other purpose, the data processing is interrupted and a message pops up that says, "Thank you for the processing time." If students are competing to see who can process the most data, they

**FIGURE 1:** The main screen of the BOINC Manager computer program



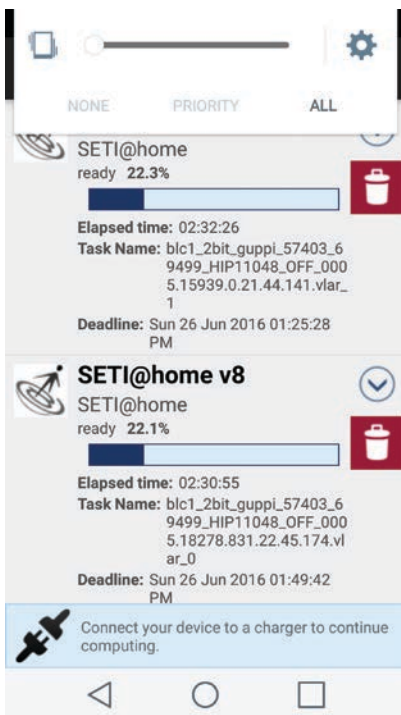
may be encouraged to use their phones less during class once they realize that checking their email interrupts the data processing (Figure 2).

## Choosing a project

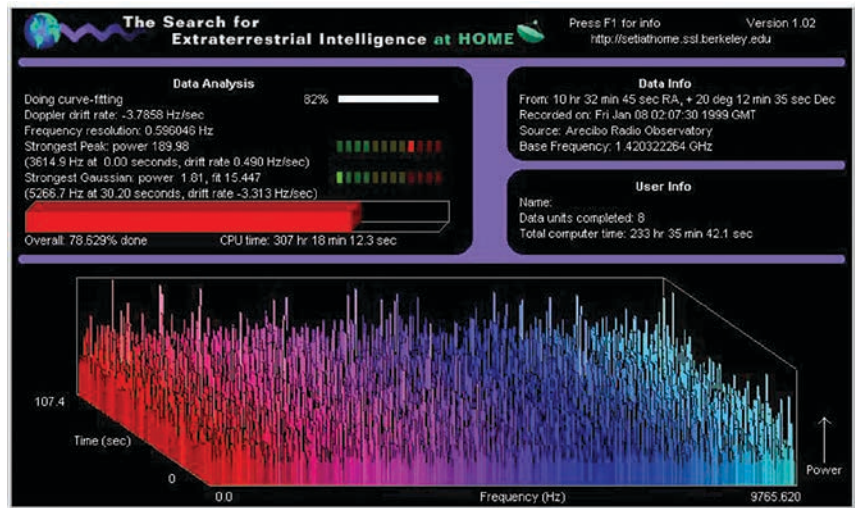
To join a project, use the BOINC project manager computer program or app. Most of the projects have specific computer hardware requirements. On the BOINC website, click “Choose Projects” for a list of the projects and their hardware requirements. There are many interesting projects, not all of which are astronomical in nature.

SETI@home (Search for Extraterrestrial Life), one of the oldest and most popular computing

**FIGURE 2:** The main screen of the BOINC Manager app



**FIGURE 3:** SETI screensaver



projects, uses your computer to analyze radio signals with data from the large radio antenna at the Arecibo Observatory in Arecibo, Puerto Rico. Once processing has begun, the computer screen shows the data being processed and how it is being processed. The largest portion of the screen displays the calculations in a colorful X, Y, and Z axis. Local radio noise or interference such as a satellite could appear as spikes. This is what the data analysis for the SETI@Home project is about—looking for anomalies or different radio patterns by first filtering out as much background radio noise as possible.

Students could help further our study of asteroids by joining the Asteroids@home project. Other than size, little is known about other physical characteristics of the hundreds of thousands of asteroids within the main asteroid belt. Much of this

size data comes from *photometric measurements*, which measure the light reflected from an asteroid as it spins about its axis of rotation. The Asteroids@home project analyzes photometric data from several observatories to help construct a light curve, which shows how the brightness of the asteroid varies over time. The shape of the light curve is a reflection of the shape of the asteroid. This light curve may also be used to create a model of a particular asteroid and can determine the asteroid rotation rate and direction of rotation (see Resources).

## World Space Week

In light of World Space Week (October 4–10, 2016), students could get to know their starry skies and the data observed by the SETI project with the smartphone app Ready, Jet, Go! This is a free app from PBS Kids that in-

cludes several game-like options and also uses the smartphone's location to determine the sky display. You can aim the phone in any direction to see the constel-

## Visible planets



**Mercury** will be visible as a morning planet, rising ahead of the Sun for the first half of this month before moving to the opposite side of the Sun and superior conjunction.



**Venus** will be visible over the western horizon at sunset and will be in close conjunction with Saturn at the end of the month.



**Mars** will be visible over the western horizon and will set a couple of hours after sunset local time.



**Ceres** will be at opposition and will rise around sunset local time and will set the following sunrise.



**Jupiter** will reappear in the morning skies over the eastern horizon toward the last half of the month.



**Saturn** will be visible over the western horizon at sunset local time and will set a couple of hours later.

lations, stars, visible planets, our Moon, and the Sun. During the day, the app can show what is above the daytime horizon and, if aimed downward, shows constellations or planets below the horizon that have yet to rise or have already set (Figure 3).

## Moon phases and dwarf planets

On Sunday, October 9, our Moon will be at its first quarter phase. Astronomy Day and International Observe the Moon Night (InOMN) are on October 8. That evening, the Moon will be near the dwarf planet Pluto; joining them are much brighter planets that are visible by the naked eye (i.e., Saturn, Mars, and Venus). The dwarf planet Ceres will rise in the east, but will not be visible (Figure 4). On InOMN, many locations will host telescope-viewing opportunities, so be sure to check with the InOMN website

for local events or to add your own event to the list (see Resources).

Due to their great distances from Earth, dwarf planets have proven to be a challenge to observe. However, Ceres, the closest dwarf planet to Earth, is an exception. Ceres reaches opposition during October. *Opposition* refers to any solar system object beyond Earth's orbit that is on the opposite side of the Earth from the Sun. It is similar to the full Moon phase in that the full Moon and any solar system object, such as Ceres, rises at sunset and sets at sunrise and is above the horizon between sunset and sunrise.

Ceres is only about seventh magnitude, meaning that it could be visible with binoculars, but it would be best to view it through a telescope. Despite the optical aid, Ceres still appears as a star-like spot of light, like the other stars in the background. Observ-

**FIGURE 4:** Evening skies on October 8



ing Ceres or any other asteroid requires several observations of the same part of the sky for days or weeks. With a star chart, carefully note the positions of the stars. Over time, one of the star-like objects—most likely an asteroid—will have moved with respect to the other stars. During October, Ceres will be moving in *retrograde*, an apparent westward motion, and will pass by the much more distant dwarf planet, Eris.

These two dwarf planets are about as alike as they are different. Eris orbits the Sun at a range extending from Neptune to Pluto: about 96 astronomical units (14,361,395,586 km; 8,923,757,497 mi.) to as close as 38 AU (5,684,719,086 km; 3,532,320,676 miles). It is a Trans-Neptune Object and is more specifically classified as a *Scattered Disk Object*. *Trans-Neptune Objects*, or TNOs, are minor planets, including small solar system objects, and dwarf planets that orbit the Sun at distances ranging from Neptune 30.1 AU (4,502,895,908 km; 2,797,969,799 mi.) to around 150 AU (22,439,680,603 km; 13,943,371,090 mi.). In 1930, Pluto became the first discovered TNO. TNOs are believed to be icy objects that have been pushed into distant and highly inclined orbits from gravitational interactions with Neptune as the solar system was forming.

Ceres is located on the Jupiter side of the main asteroid belt. Ceres is only about 2.5 AU (373,994,676 km; 232,389,518 mi.) from the Sun and has an inclina-

## For students

1. As teams, students could see which team completes the most work for a project in a given amount of time.
2. Using the resources in this column, students could learn how to track minor planets like an asteroid or complete the asteroid search activity.
3. An alternate method for determining an asteroid's shape is by timing an asteroid's *occultation*, when a solar system object passes between our line of sight and a more distant object such as stars and galaxies. See Resources for a previous column [The Shape of Things] about occultation timing of asteroids.

## October

- |      |   |    |  |
|------|---|----|--|
| 1    | New Moon                                  | 20 | Orionid shower peak                      |
| 3    | Waxing crescent Moon near Venus           | 21 | Dwarf planet Ceres at opposition         |
| 4    | Moon at apogee: 406,100 km [252,338 mi.]  |    | Last quarter Moon                        |
| 4–10 | World Space Week                          | 22 | Sun enters astrological sign Scorpio     |
| 6    | Moon near Saturn                          | 25 | Moon at ascending node                   |
| 8    | International Observe the Moon Night      |    | Venus-Antares                            |
| 9    | First quarter Moon                        | 27 | Mercury at superior conjunction          |
| 11   | Mercury near Jupiter                      | 28 | Moon near Jupiter                        |
| 13   | Moon at descending node                   | 29 | Mars at perihelion                       |
|      | Moon occults Neptune                      | 30 | New Moon                                 |
| 15   | Uranus at opposition                      |    | Venus near Saturn                        |
|      | Full Moon                                 |    | Sun enters the astronomical sign Libra   |
| 16   | Moon at perigee: 357,900 km [222,389 mi.] | 31 | Moon at apogee: 406,700 km [252,712 mi.] |
| 19   | Moon very near Aldebaran                  |    |  |

tion from the plane of the ecliptic of about  $10^\circ$  compared to the  $45^\circ$  inclination of Eris. When first discovered, Eris was considered to be a planet, but later was classified as a dwarf planet. When Ceres was discovered, it was classified as a minor planet. As time went by and more asteroids were discovered, Ceres was reclassified as an asteroid, albeit the largest and only spherical-shaped asteroid. Now, due to its round shape, Ceres is classified as a dwarf planet. The *Dawn* spacecraft, after spend-

ing a year in orbit around the asteroid Vesta, is currently in orbit around Ceres (see Resources). ●

### RESOURCES

Arecibo Observatory—[www.naic.edu](http://www.naic.edu)

Asteroids@home—[www.asteroidsathome.net/boinc](http://www.asteroidsathome.net/boinc)

Asteroid search activity—[http://dawn.jpl.nasa.gov/DawnClassrooms/1\\_hist\\_dawn/index.html](http://dawn.jpl.nasa.gov/DawnClassrooms/1_hist_dawn/index.html)

BOINC—<http://boinc.berkeley.edu>

Cassini Saturn mission—<http://saturn.jpl.nasa.gov>

Dawn Mission—<http://dawn.jpl.nasa.gov>

Dwarf planet Eris—[http://solarsystem.](http://solarsystem.nasa.gov/planets/eris)

[www.heavens-above.com](http://www.heavens-above.com)

How to find asteroids and comets to observe—<http://lcogt.net/education/article/how-find-asteroids-and-comets-observe>

International Observe the Moon Night—<http://moon.nasa.gov/inomn.cfm>

Ready, Jet, Go App—[www.pbskids.org/apps/ready-jet-go-space-explorer.html](http://www.pbskids.org/apps/ready-jet-go-space-explorer.html)

Riddle, B. 2015. Scope on the Skies: The shape of things. *Science Scope* 39 [3]: 88–89.

World Space Week—[www.worldspaceweek.org](http://www.worldspaceweek.org)

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