Name: _____

Astronomy 141
Winter Quarter 2012

Homework #5

Due Friday, March 9 in class

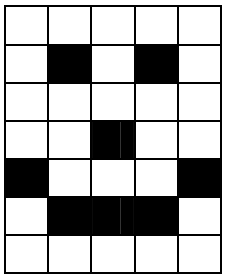
Instructions

This handout is your worksheet. In cases where a calculation is called for, please show your work so we can evaluate your answer and assign partial credit as appropriate. Answers given without showing your work will receive no credit. We will only accept homework turned in on this worksheet.

In 1974, SETI pioneer Frank Drake (of Drake Equation fame) and his colleagues used the giant Arecibo radio telescope in Puerto Rico to transmit a pictographic message toward the star cluster M13. The pictogram was coded as a stream of 1s and 0s transmitted in a very narrow frequency band in the "water hole", and repeated over and over for a long time so that any errors in transmission or reception could be averaged over and the message received in full without missing bits.

The pictogram encoding followed a few, simple rules that any intelligent species possessing radio technology and basic mathematics should be able to decode without instructions:

- The pictogram is drawn on a 2-dimensional grid that has unequal horizontal and vertical dimensions such that the vertical size always *larger* than the horizontal size. Further, each of side of the grid is a **prime number** – a type of number that cannot be divided by any other number except itself with no remainder. The first 20 prime numbers are 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, and 71. For example a 5×7 prime-number grid (horizontal × vertical) would be used to make a small pictogram that is 35 bits long.
- The pictogram is drawn by laying out the desired prime-number grid on a sheet of graph paper, and then filling in squares with black to form the picture. For example, a smiley-face pictogram draw on a 5×7 prime-number grid would look like this:



- Next, "digitize" the pictogram by assigning 1 to black squares and 0 to white (blank) squares:

0	0	0	0	0
0	1	0	1	0
0	0	0	0	0
0	0	1	0	0
1	0	0	0	1
0	1	1	1	0
0	0	0	0	0

- Finally, the 2-dimensional digitized pictogram is converted into a 1-dimensional "data stream" of 1s and 0s by unpacking the grid row by row, starting at the upper left. For our smiley-face pictogram above, the 2D digitized pictogram unpacks in this 1-D data stream:

00000010100000000100100010111000000

First Contact: A Radio Message from OGLE-2006-109L

A radio transmission like the 1974 Arecibo Message has been received from the direction of the star system OGLE-2006-109L, a Solar System analog discovered in 2008 using gravitational microlensing by a team of astronomers led by Ohio State.

The data stream received consists of 667 bits. A digital copy is available on the class website: http://www.astronomy.ohio-state.edu/~pogge/Ast141/Homework/hw5data.txt.

Part 1: Decode the Message from OGLE-2006-109L

1. What pair of prime numbers gives you the dimensions of the alien pictogram? **Hint**: the picture is rectangular, a little higher than it is wide – so take the square root of 667 and use that to get you close to one of the numbers, but remember **both** must be primes and product of the two numbers must be **exactly 667 bits**.

2. Using the grid provided (or a grid in, for example, a spreadsheet program like Excel), decode the image (note: the grid is larger than you need in both dimensions). Attach a copy of your resulting decoded pictogram.

3. How do you interpret this message?

Part 2: Create and Encode a Reply Message

Now that we have someone to talk to, and have decoded their message to us, we want to send a response that says "we got your message". It makes sense to use the same basic message format in our reply – think of it as the "response" half of an interstellar "call and response" shout-out to the denizens of OGLE-2006-109L.

4. Create your response message using the same 667-bit prime-number grid as the message received (a good way of making it obvious that this is a response to their message).

5. Encode your message as a 1-dimensional data stream of 1s and 0s, and create a flat text (.txt) file with the 1s and 0s. It should look like the original message file you used in Part 2 above. Put this reply message text file into the Dropbox Folder setup for this purpose on the Carmen website for this class. If you have problems with the Carmen dropbox, you can mail your data stream as an attachment to Prof. Pogge (pogge.1@osu.edu) *and* TA Carl Coker (coker.25@osu.edu). We will decode your message and see how you did. Credit is only given for a message that we can decode and interpret – if we get garbage (bad encoding), no points.

Please keep your messages simple, clean, and "on-topic" as regards the original message. We don't want a big maize and blue Death Star showing up in Earth orbit and transmitting the message "Nobody says THAT about our moms..." before going all Galactic Empire on us.

Pictogram grid worksheet (note: **this grid is larger than the grid you need**)