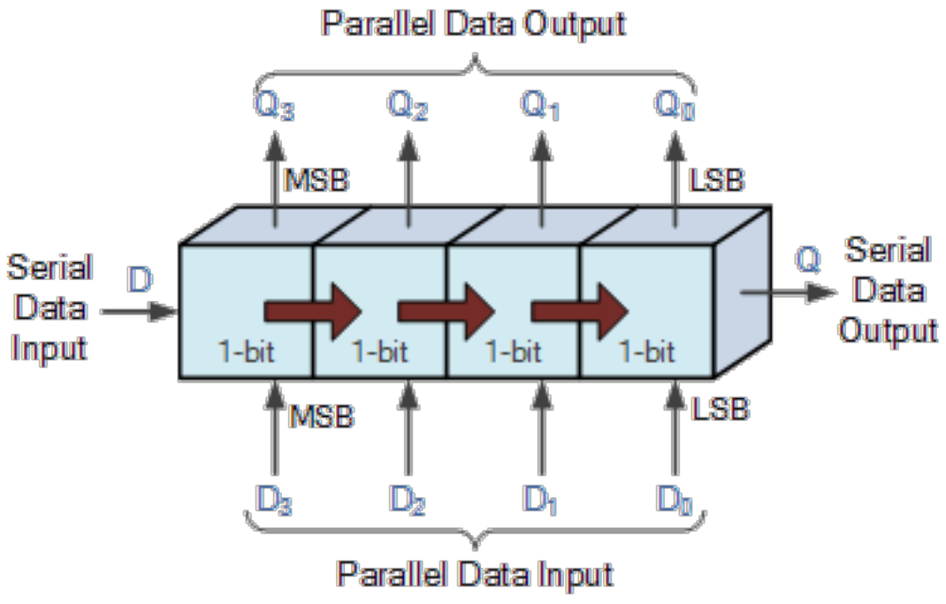
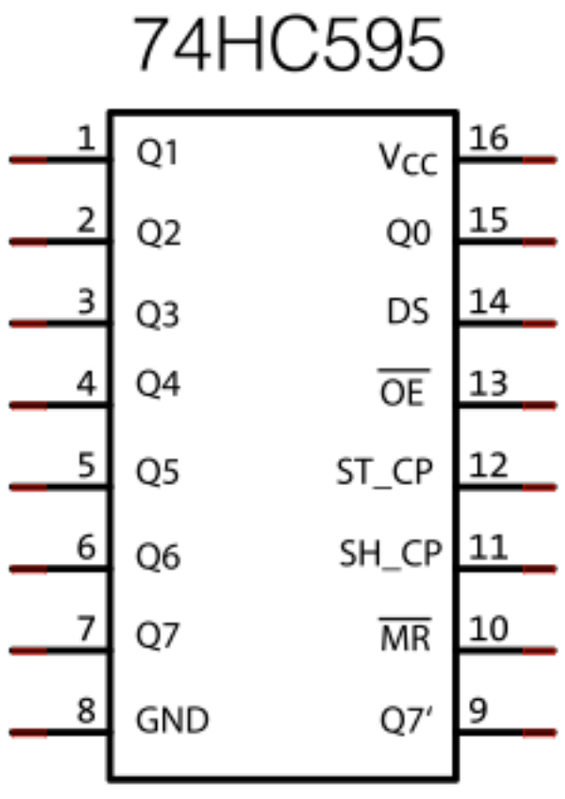
PHYSICAL COMPUTING

WEEK 05





http://www.cs.uregina.ca/Links/class-info/207/Lab8/

Everything in computing can be **distilled to binary**

Each of these values represent a state, either on or off
00000000

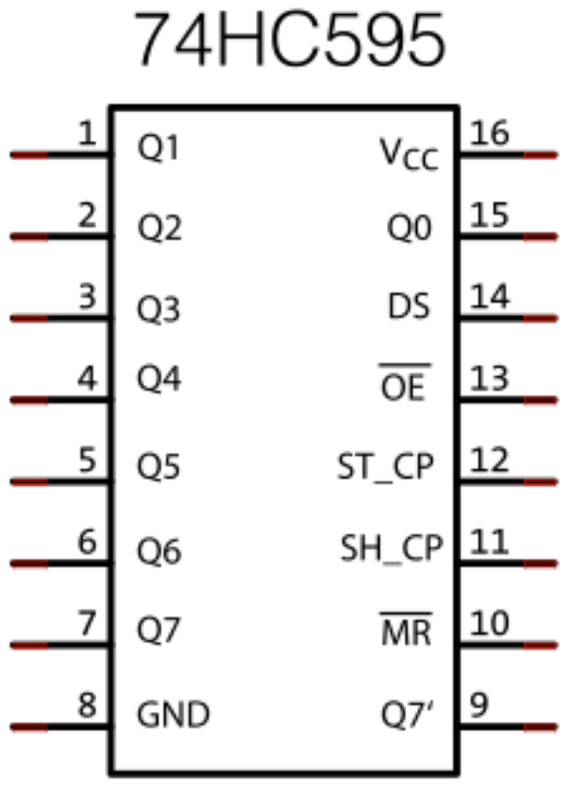
To change 00000000 to 00000001 we use a left bit shift operator **<<**
x = 0
1 = 0 << 1
This is a logical shift. You can go right **>>** or left **<<**
A shift register is essentially a left shift in hardware form

bit shifted out	pattern of bits								bit shifted in
	0	0	0	0	0	1	0	1	
0	0	0	0	0	1	0	1	0	0
0	0	0	0	1	0	1	0	0	0
0	0	0	1	0	1	0	0	1	1
0	0	1	0	1	0	0	1	1	1
0	1	0	1	0	0	1	1	0	0
1	0	1	0	0	1	1	0	0	0
0	1	0	0	1	1	0	0	1	1
1	0	0	1	1	0	0	1	1	1

PIN OUT

The pieces of this diagram that are data related are:

Q0 to Q7 (pin 1 to 7 and 15) are the eight pins containing the pattern. These pins are also know as the "output pins"
Q7' (pin 9) is the bit that gets rolled (or shifted) out.
DS (pin 14) is the bit that is getting rolled (shifted) in.



GND (pin 8) ground
VCC (pin 16) is connected to 5V

MR (pin 10) is the "Master Reclear".

It will "empty" the whole shift register if pulled LOW. Notice that in our starting circuit, this pin is connected to 5V. This is because it must be pulled to HIGH to enable the shift register.

SH_CP (pin 11) is the "SHift register Clock Pin".

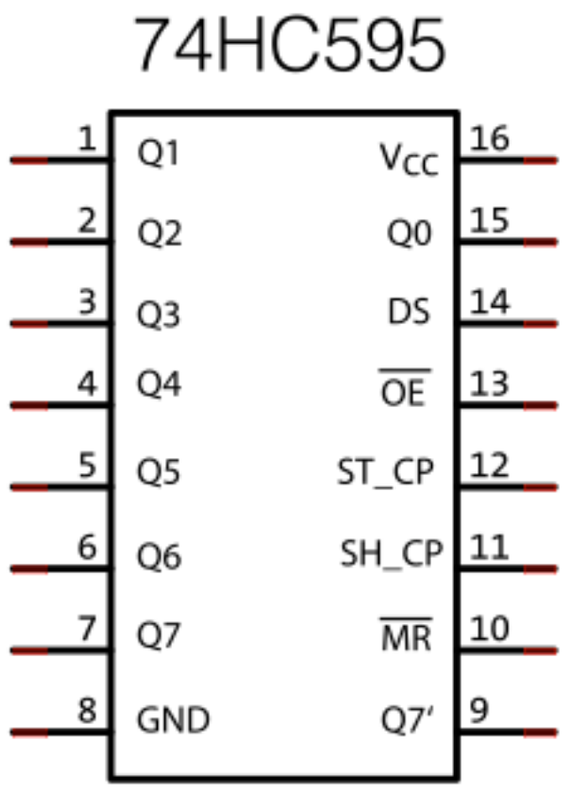
When this pin is pulled HIGH, it will shift the register. This pin will alternate between HIGH and LOW. In our analogy, this is like the "bell" that indicates that a change will occur.

ST_CP (pin 12) is the "STorage register Clock Pin".

Needs to be pulled to HIGH to have the "pattern" of bits be output by the shift register. This will be pulled HIGH after
SH_CP has gone LOW. This pin will alternate between HIGH and LOW as well. This pin could be analogous to a "display" trigger. You could have multiple shifts, but only display the ending pattern.

OE (pin 13) is the "Output Enable" pin.

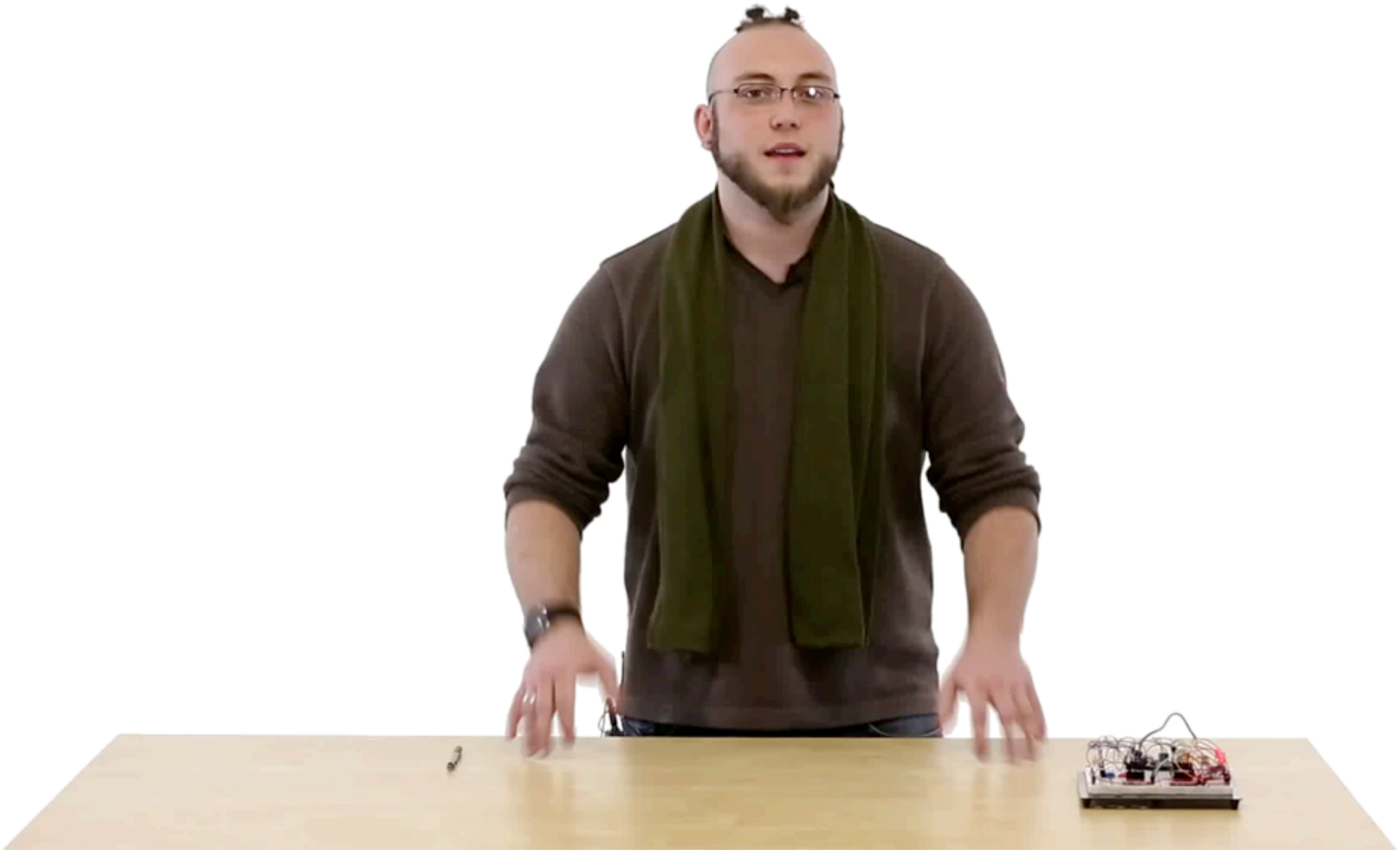
This pin enables the output when tied to GND and disables output when HIGH. Notice how our circuit has pin 13 tied to ground.



Using for Arduino

DS (the bit to be shifted in)
ST_CP (the clock that controls when the output gets displayed)
SH_CP (the clock that controls when the shifting occurs)
These three are related as follows:

When the signal on the SH_CP-pin goes HIGH, all the values get shifted and a new value (from DS) gets shifted in. When you want the "pattern" that has been created to be output, you must also change the ST_CP pin to HIGH. This updates the output-pins with the new data.



https://www.youtube.com/watch?v=6BLj9Ak2Djs

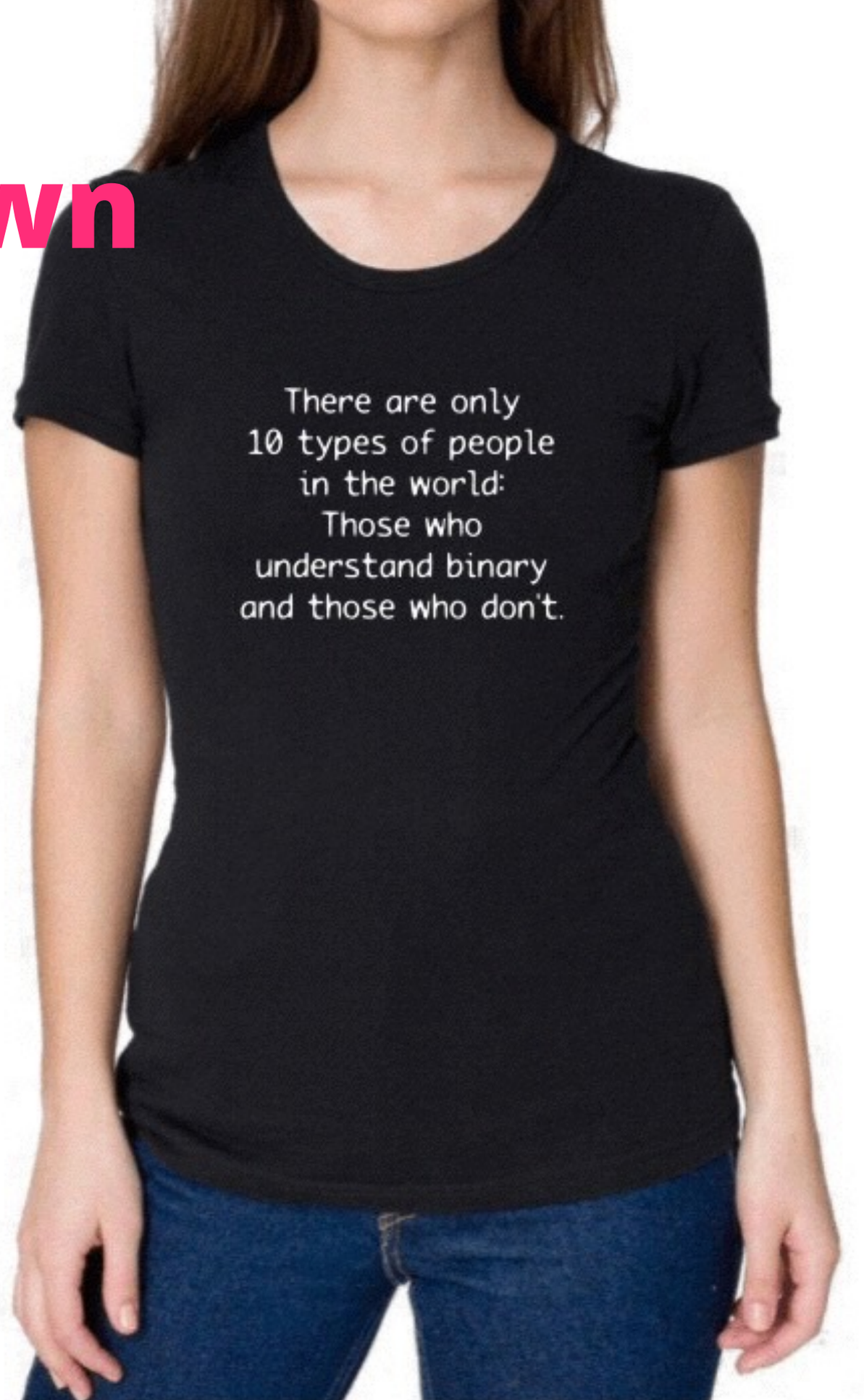
CODE BREAKDOWN

/class_code/shift_registors.ino

```
/*
-----------------------------------------------------------------
-
 *      |  Arduino Experimentation Kit Example Code
|
 *      |  CIRC-05 .: 8 More LEDs :. (74HC595 Shift
Register)   |
 *
-----------------------------------------------------------------
-
 *
 * We have already controlled 8 LEDs however this does
it in a slightly
 * different manner. Rather than using 8 pins we will
use just three
 * and an additional chip
```

Binary breakdown

	128	64	32	16	8	4	2	1
8 bit binary digit	1	0	1	1	0	0	0	1
	128 + 32 + 16 + 1 = 177							



Binary & and | and ^

```
01001000 &
10111000 =
--------
00001000
```

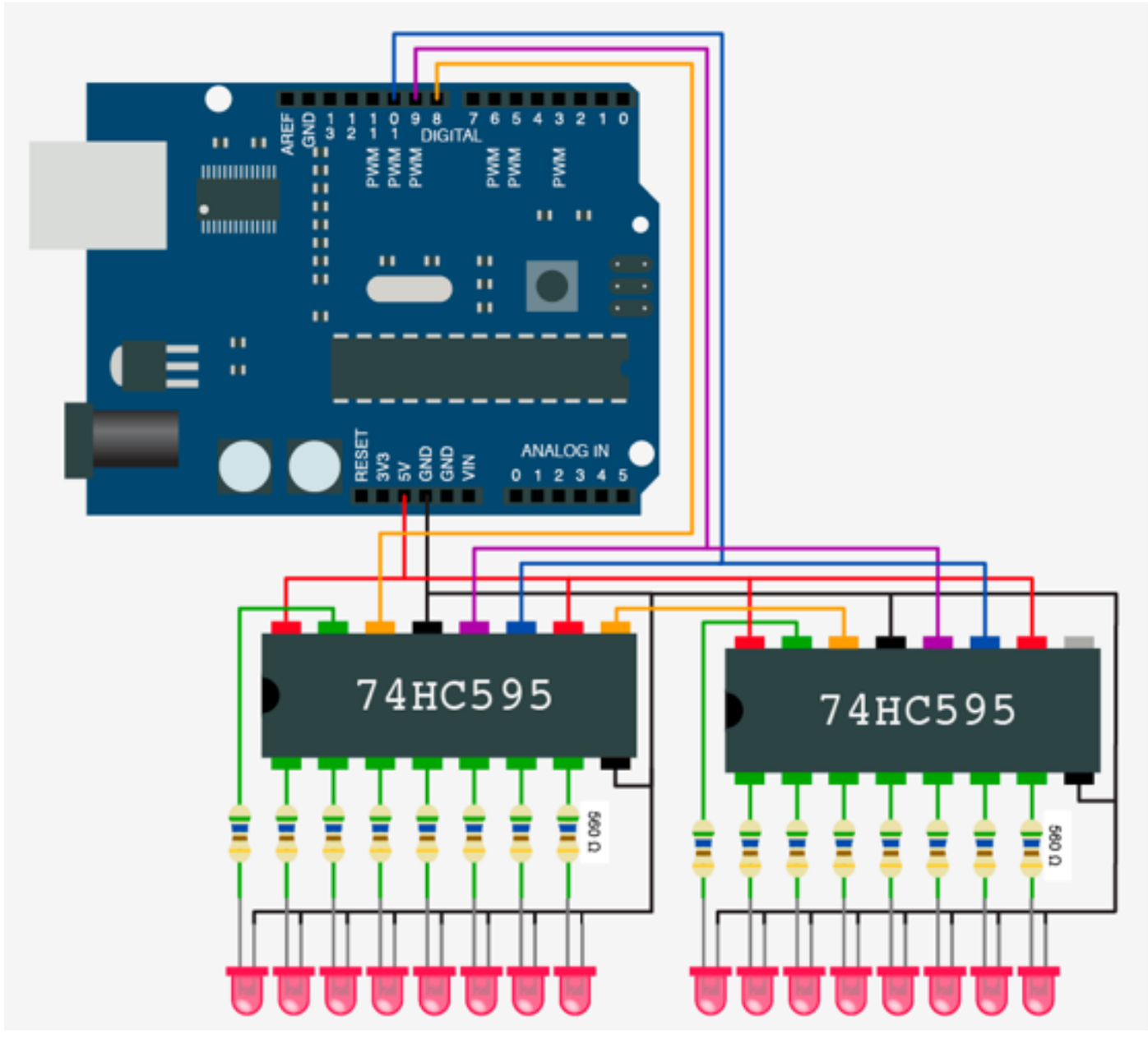
```
01001000 |
10111000 =
--------
11111000
```

```
01110010 ^
10101010
--------
11011000
```

http://www.cs.uregina.ca/Links/class-info/207/Lab8/

Chaining

http://bildr.org/2011/02/74hc595/



8 Bit display