CS122A: Intermediate Embedded and Real Time Operating Systems

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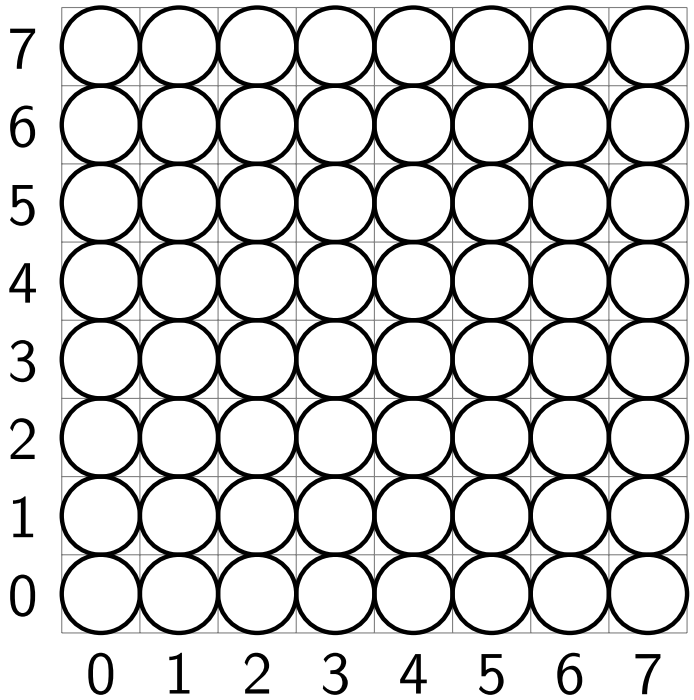
Light-Emitting Diode (LED)

- Two-lead semiconductor light source
- Emits light when activated based on energy band gap and integrated optical components
- Provide many benefits over incandescent lighting:
  - Lower energy consumption
  - Longer lifetime
  - Improved physical robustness
  - Smaller size
  - and Faster switching

LED Matrix

Writing to an LED Matrix



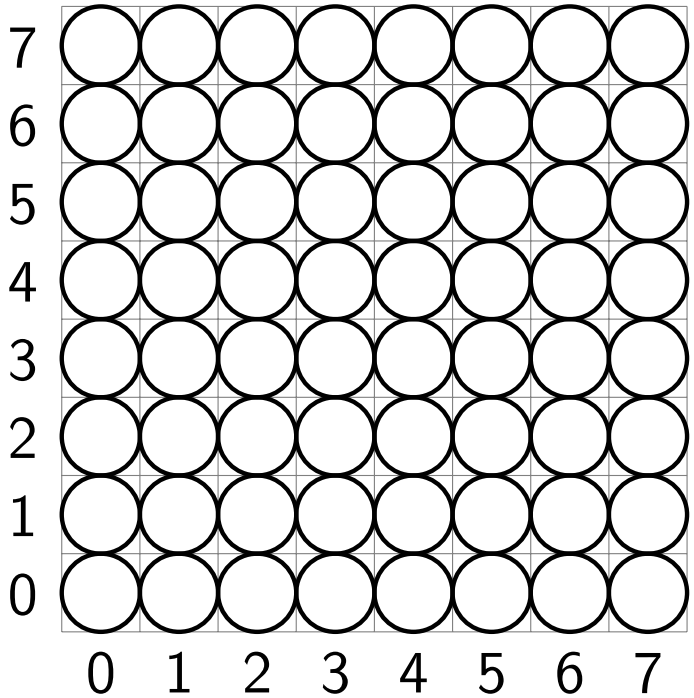
LED Matrix

7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

Internal 2D array

LED Matrix

Writing to an LED Matrix



LED Matrix

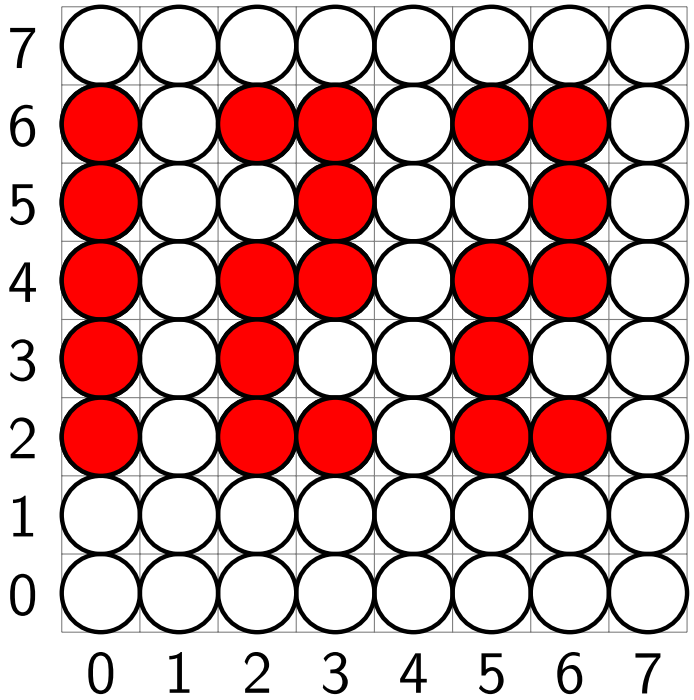
7	0	0	0	0	0	0	0	0
6	**1**	0	**1**	**1**	0	**1**	**1**	0
5	**1**	0	0	**1**	0	0	**1**	0
4	**1**	0	**1**	**1**	0	**1**	**1**	0
3	**1**	0	**1**	0	0	**1**	0	0
2	**1**	0	**1**	**1**	0	**1**	**1**	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

Internal 2D array

1. Update internal 2d array representation (boolean)

LED Matrix

Writing to an LED Matrix



LED Matrix

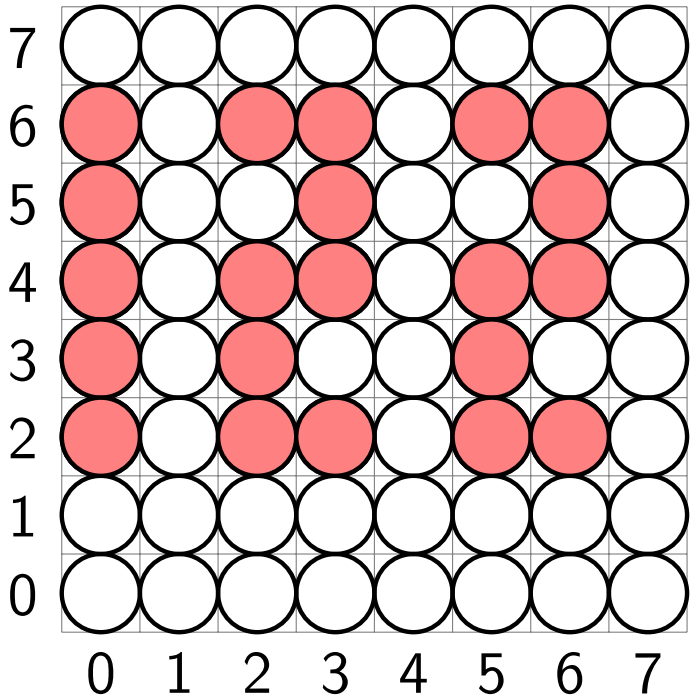
7	0	0	0	0	0	0	0	0
6	**1**	0	**1**	**1**	0	**1**	**1**	0
5	**1**	0	0	**1**	0	0	**1**	0
4	**1**	0	**1**	**1**	0	**1**	**1**	0
3	**1**	0	**1**	0	0	**1**	0	0
2	**1**	0	**1**	**1**	0	**1**	**1**	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

Internal 2D array

1. Iterate over each LED and write the appropriate value

LED Matrix

Writing to an LED Matrix



LED Matrix

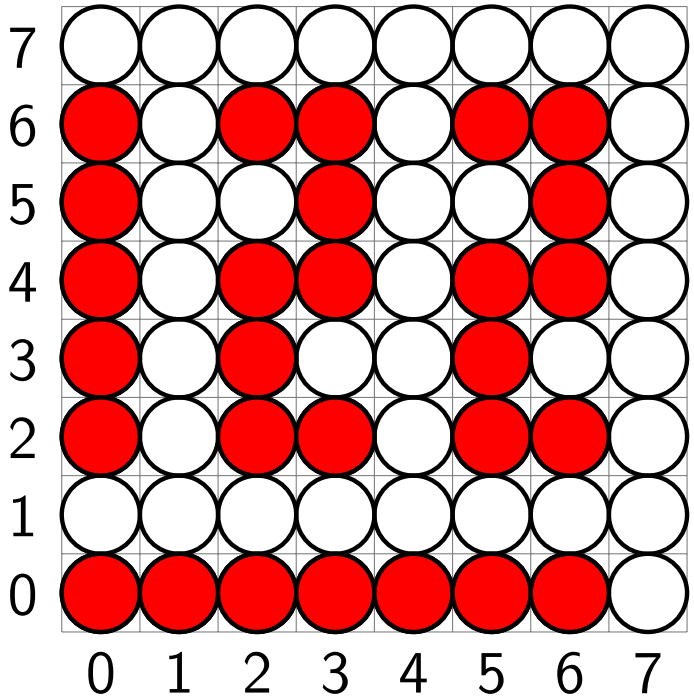
	0	1	2	3	4	5	6	7
7	0	0	0	0	0	0	0	0
6	**1**	0	**1**	**1**	0	**1**	**1**	0
5	**1**	0	0	**1**	0	0	**1**	0
4	**1**	0	**1**	**1**	0	**1**	**1**	0
3	**1**	0	**1**	0	0	**1**	0	0
2	**1**	0	**1**	**1**	0	**1**	**1**	0
1	0	0	0	0	0	0	0	0
0	**1**	**1**	**1**	**1**	**1**	**1**	**1**	0

Internal 2D array

1. LED's will begin to fade

LED Matrix

Writing to an LED Matrix



LED Matrix

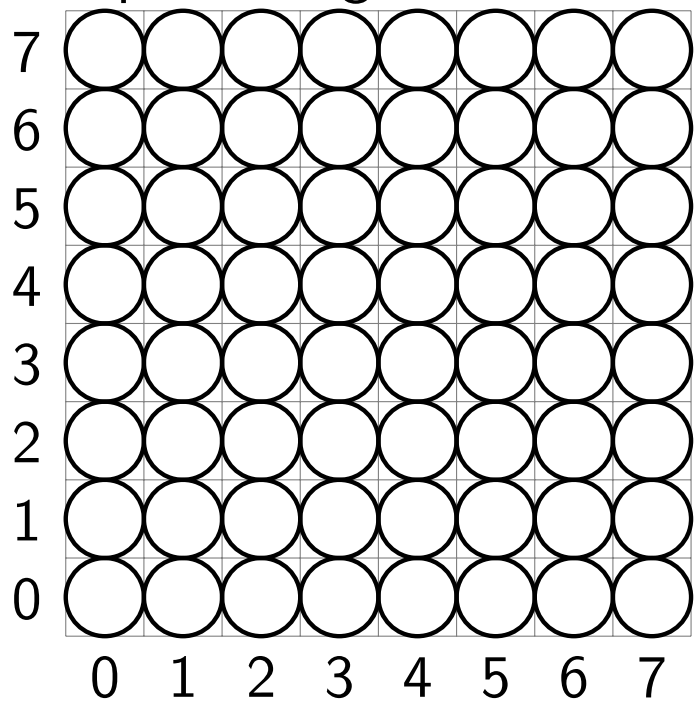
	0	1	2	3	4	5	6	7
7	0	0	0	0	0	0	0	0
6	**1**	0	**1**	**1**	0	**1**	**1**	0
5	**1**	0	0	**1**	0	0	**1**	0
4	**1**	0	**1**	**1**	0	**1**	**1**	0
3	**1**	0	**1**	0	0	**1**	0	0
2	**1**	0	**1**	**1**	0	**1**	**1**	0
1	0	0	0	0	0	0	0	0
0	**1**	**1**	**1**	**1**	**1**	**1**	**1**	0

Internal 2D array

1. LED's will begin to fade...and need to be updated every so often.

RGB LED Matrix

The internal 2D array can now hold the values 0-7, with the binary value representing the RGB value.



7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

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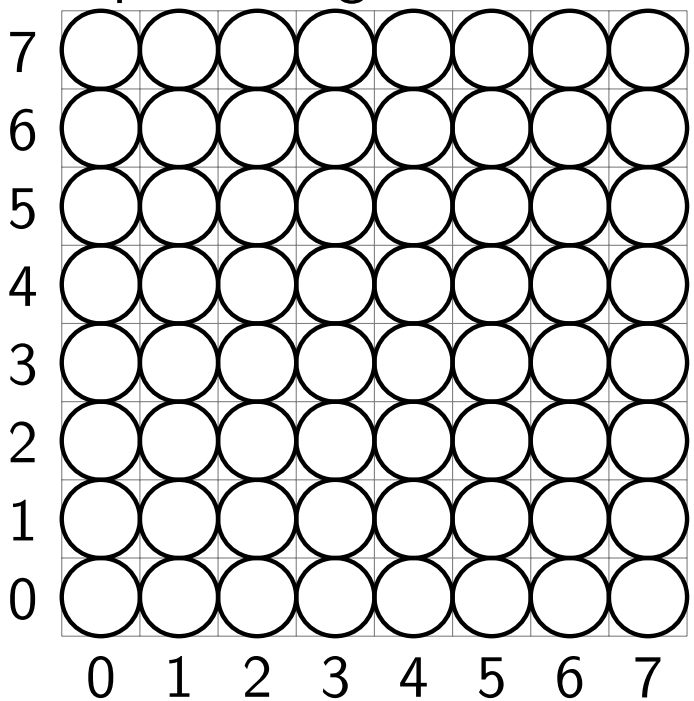
RGB LED Matrix

The internal 2D array can now hold the values 0-7, with the binary value representing the RGB value.

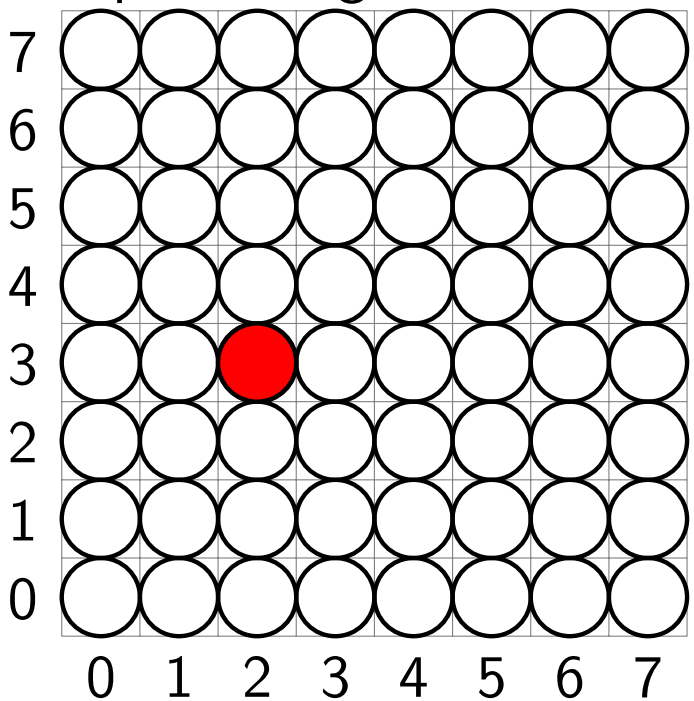


7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	**4**	0	0	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

- $4 \rightarrow b100 \rightarrow$ Red

RGB LED Matrix

The internal 2D array can now hold the values 0-7, with the binary value representing the RGB value.

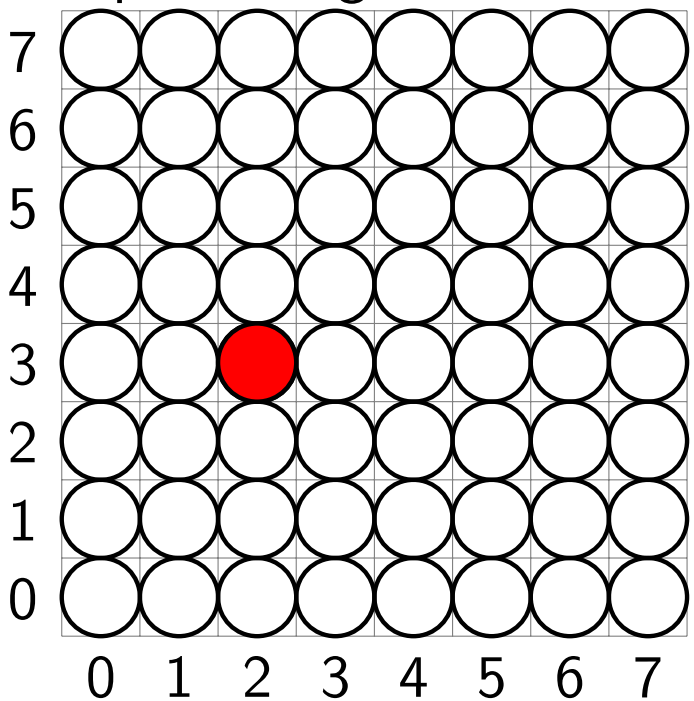


7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	**4**	0	0	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

- $4 \rightarrow b100 \rightarrow$ Red

RGB LED Matrix

The internal 2D array can now hold the values 0-7, with the binary value representing the RGB value.

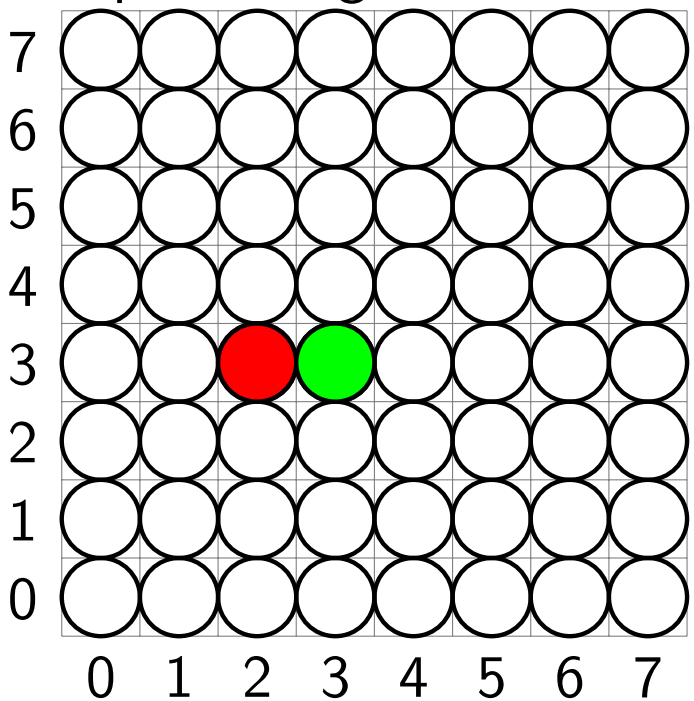


7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	**4**	**2**	0	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

- $2 \rightarrow b010 \rightarrow$ Green

RGB LED Matrix

The internal 2D array can now hold the values 0-7, with the binary value representing the RGB value.

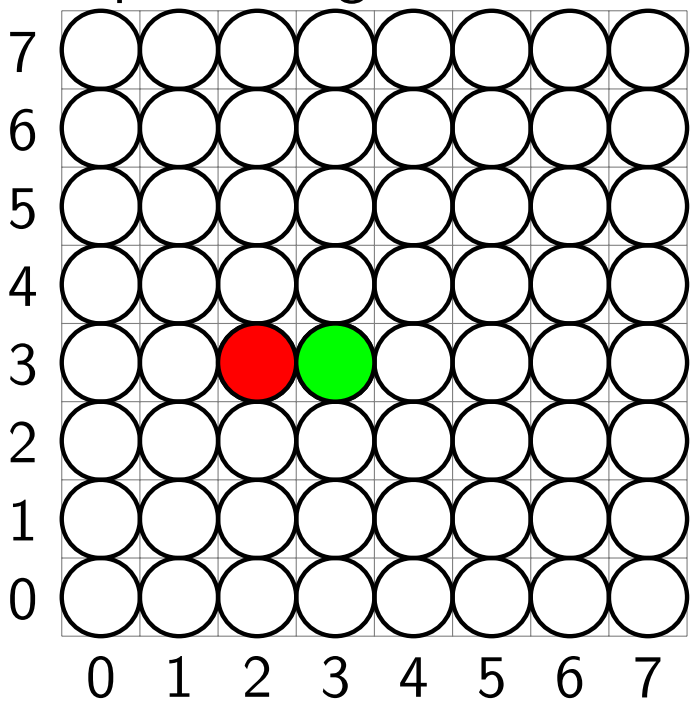


7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	**4**	**2**	0	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

- $2 \rightarrow b010 \rightarrow$ Green

RGB LED Matrix

The internal 2D array can now hold the values 0-7, with the binary value representing the RGB value.

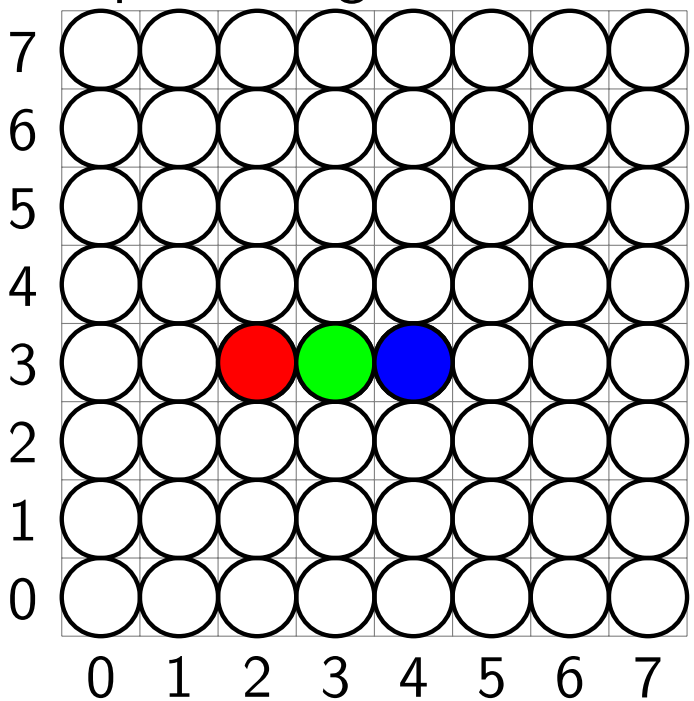


7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	**4**	**2**	**1**	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

- $1 \rightarrow b001 \rightarrow$ Blue

RGB LED Matrix

The internal 2D array can now hold the values 0-7, with the binary value representing the RGB value.

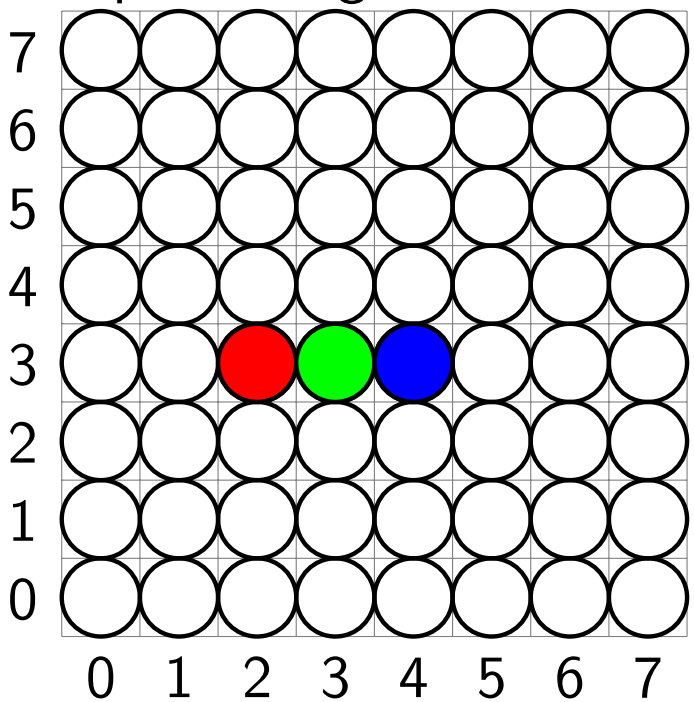


7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	**4**	**2**	**1**	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

- $1 \rightarrow b001 \rightarrow$ Blue

RGB LED Matrix

The internal 2D array can now hold the values 0-7, with the binary value representing the RGB value.

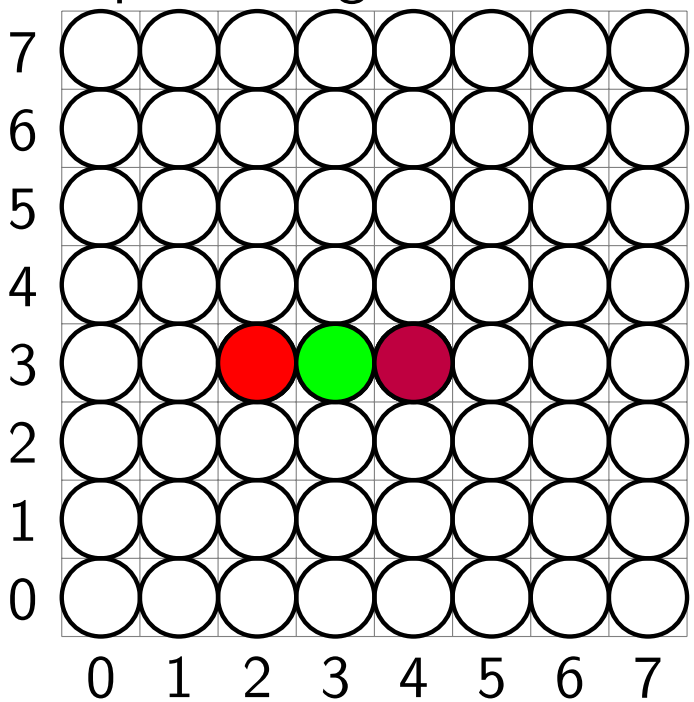


7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	**4**	**2**	**5**	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

- $5 \rightarrow b101 \rightarrow$ Purple

RGB LED Matrix

The internal 2D array can now hold the values 0-7, with the binary value representing the RGB value.



7	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
3	0	0	**4**	**2**	**5**	0	0	0
2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
	0	1	2	3	4	5	6	7

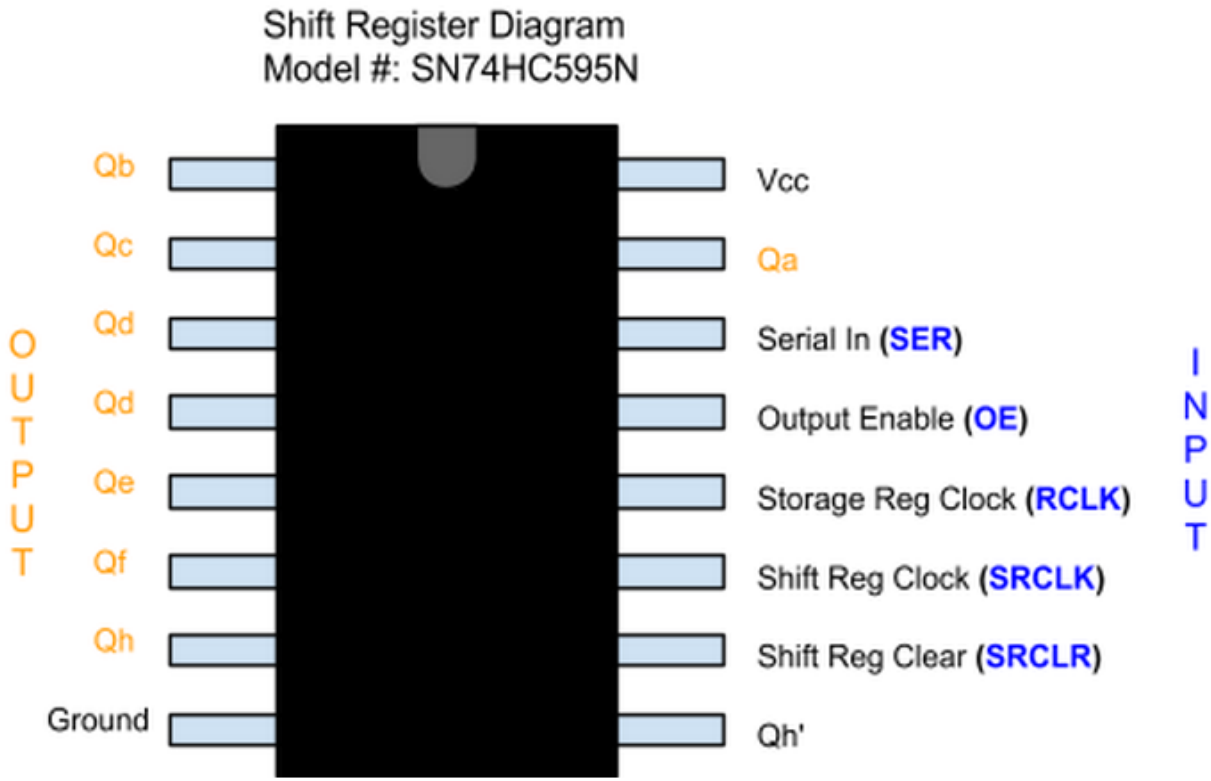
- $5 \rightarrow b101 \rightarrow$ Purple

LED Examples

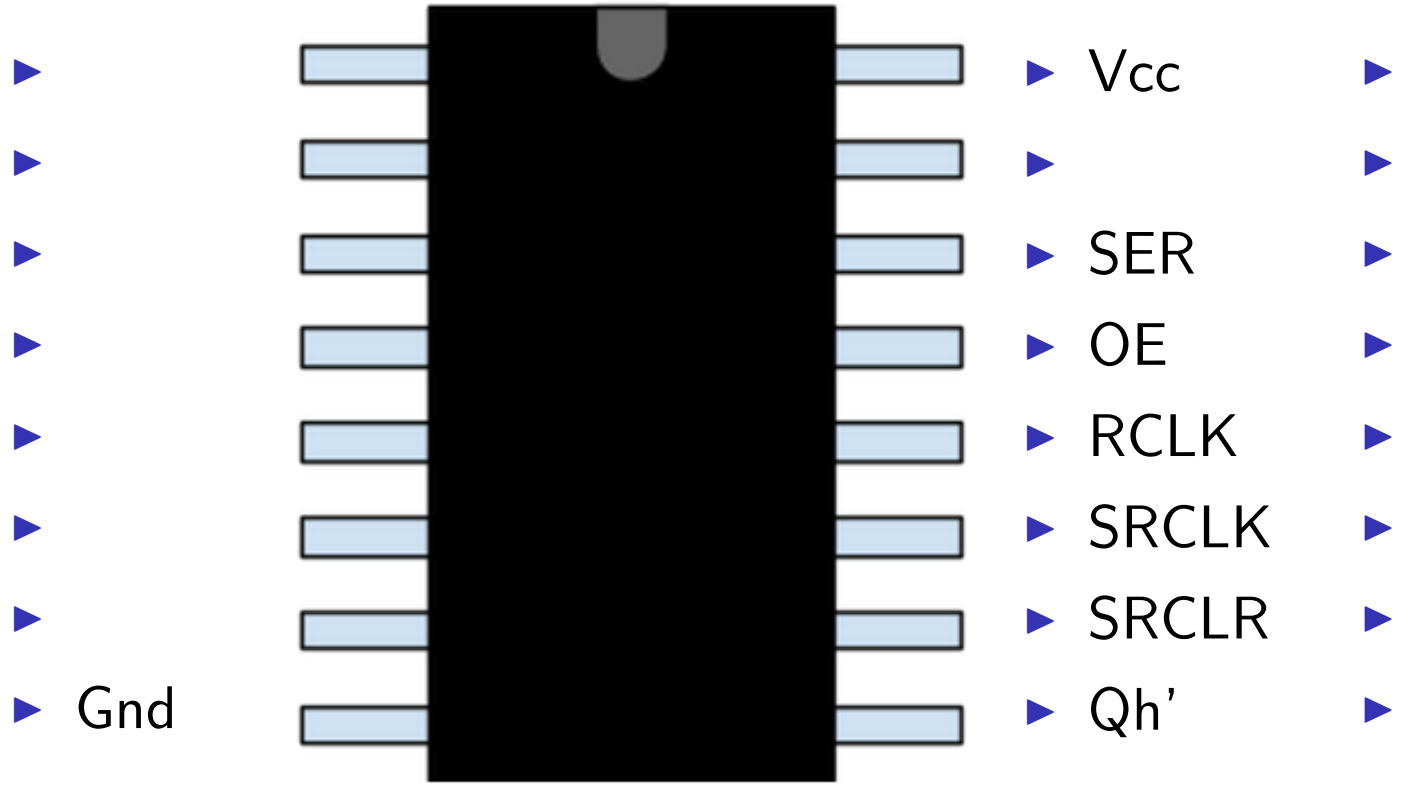
- Student project (10s- 40s)
- 8x8x8 cube
- 32x32x32 cube
- LED infinity table
- LED table demo (tetris)
- LED Reactive table

Shift Registers

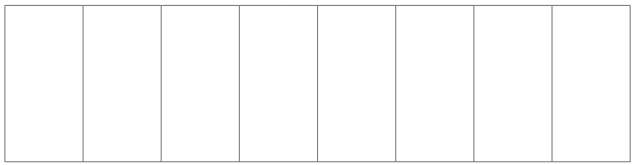
- An 8x8 RGB LED Matrix takes 32 pins to run
- The ATMega 1284 we are using has 32 pins
- Shift Registers allow you to use less pins



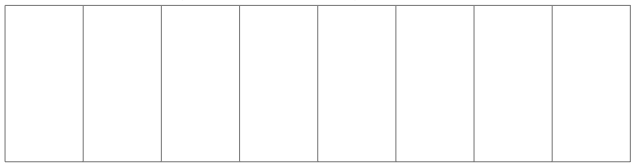
Shift Registers



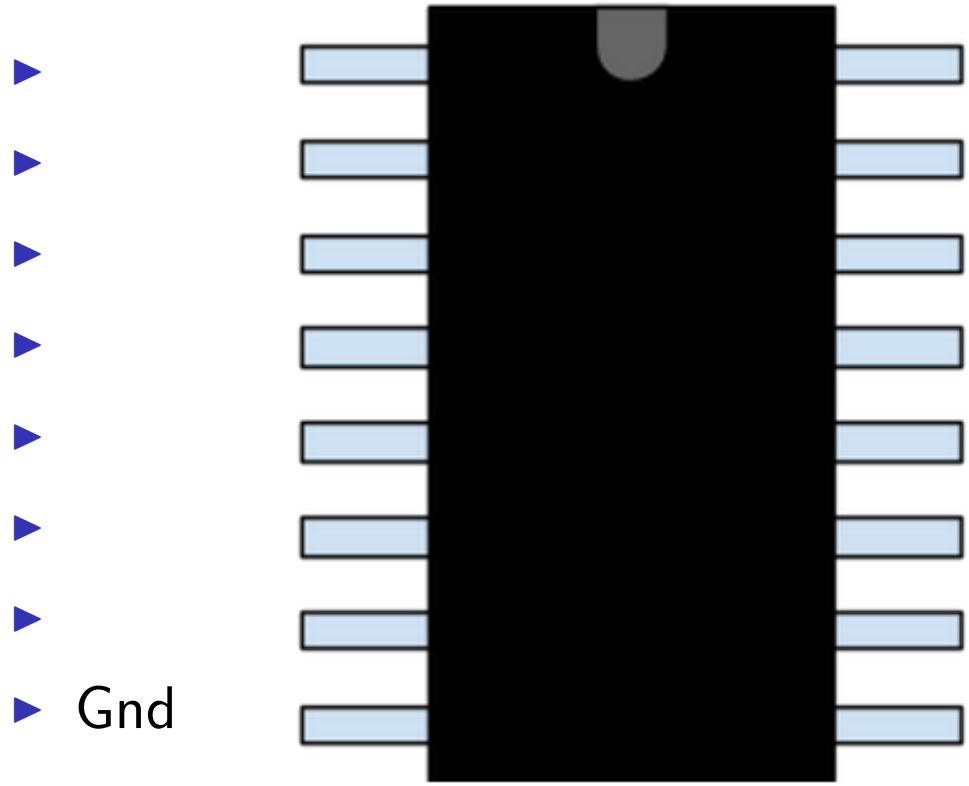
"Shift" Register



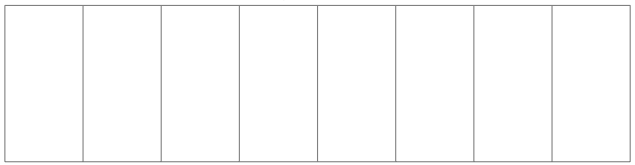
"Storage" Register



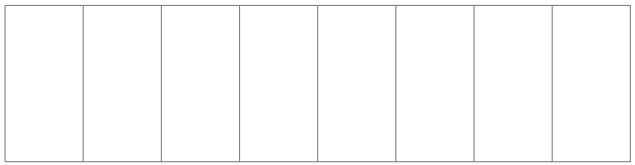
Shift Registers



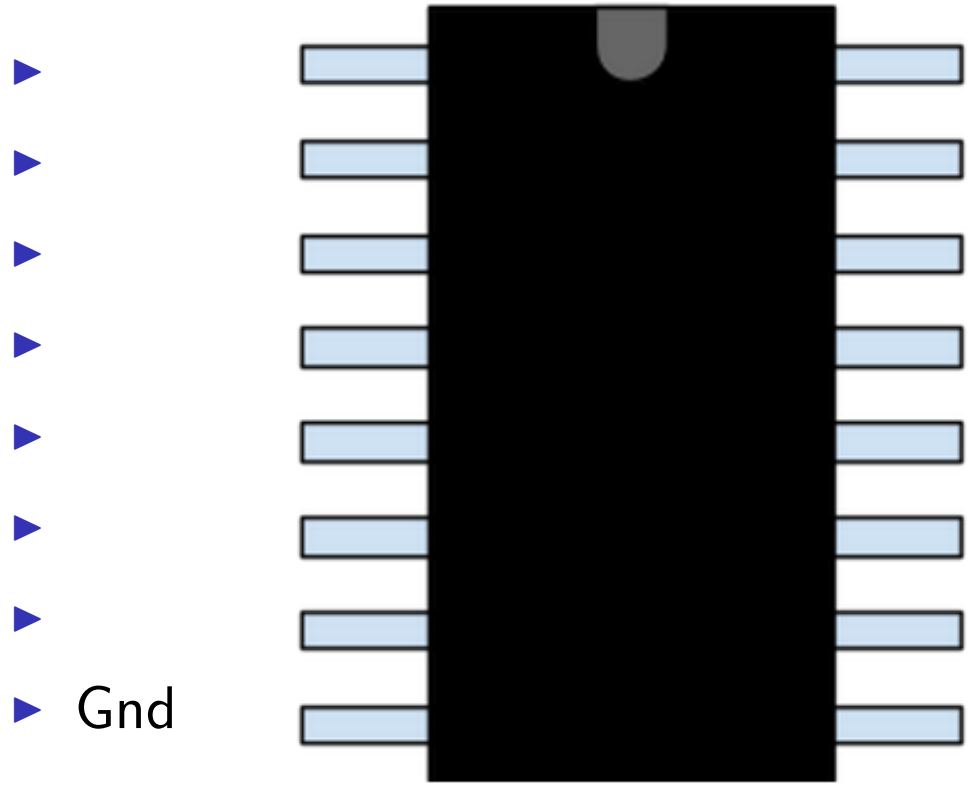
"Shift" Register



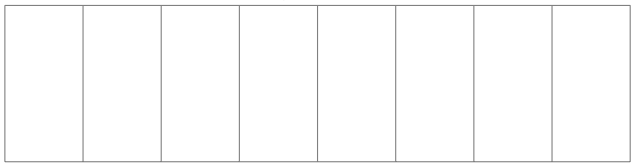
"Storage" Register



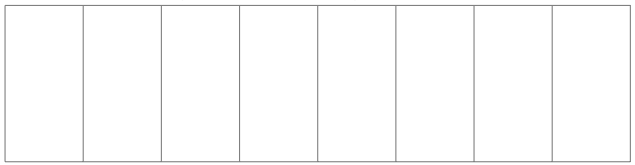
Shift Registers



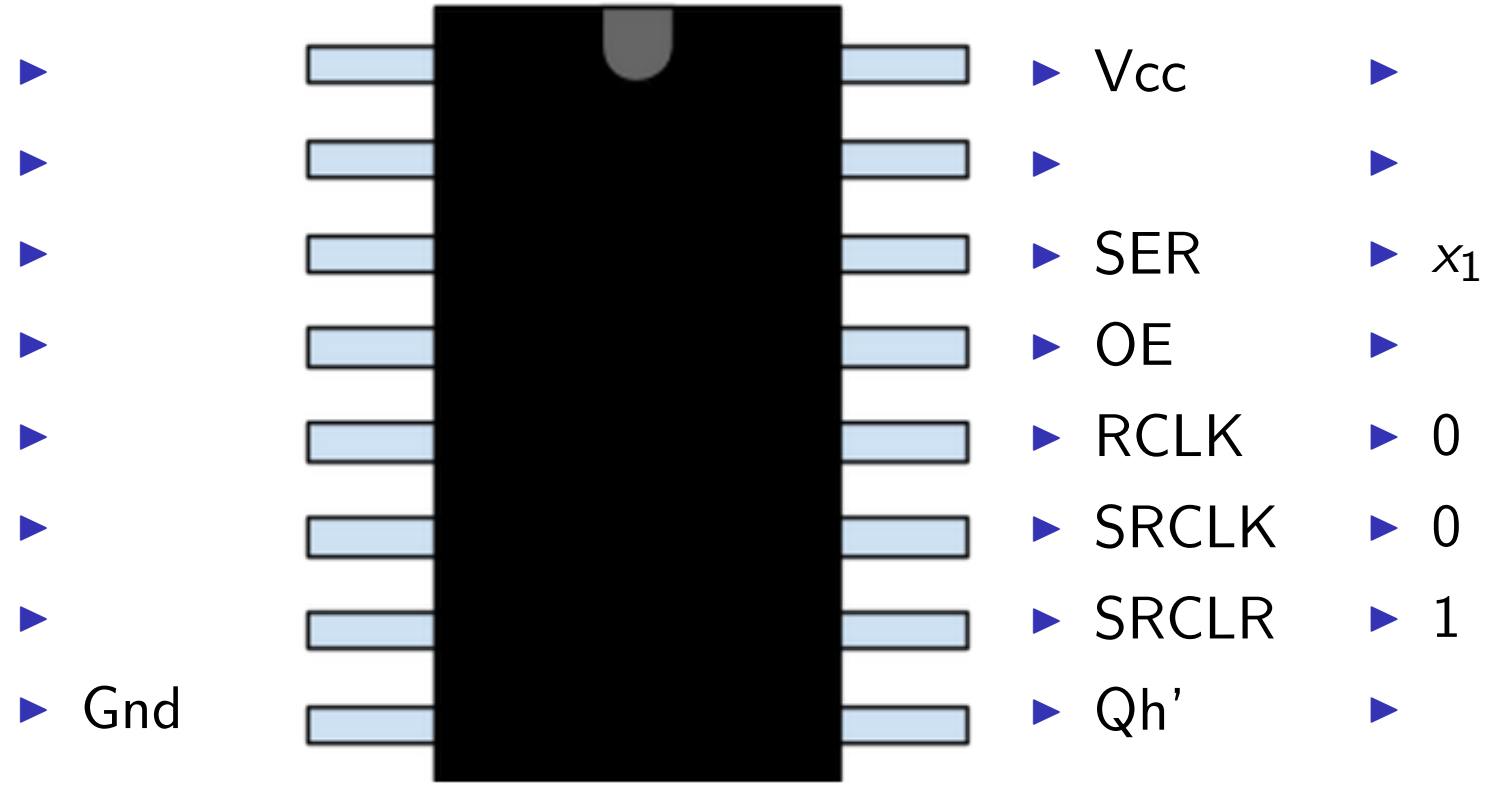
"Shift" Register



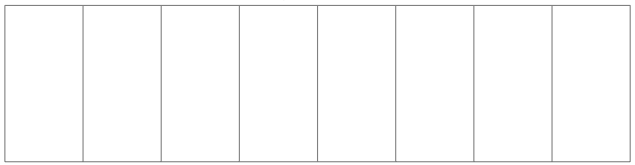
"Storage" Register



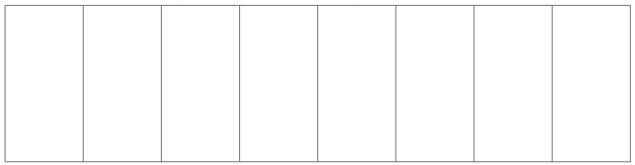
Shift Registers



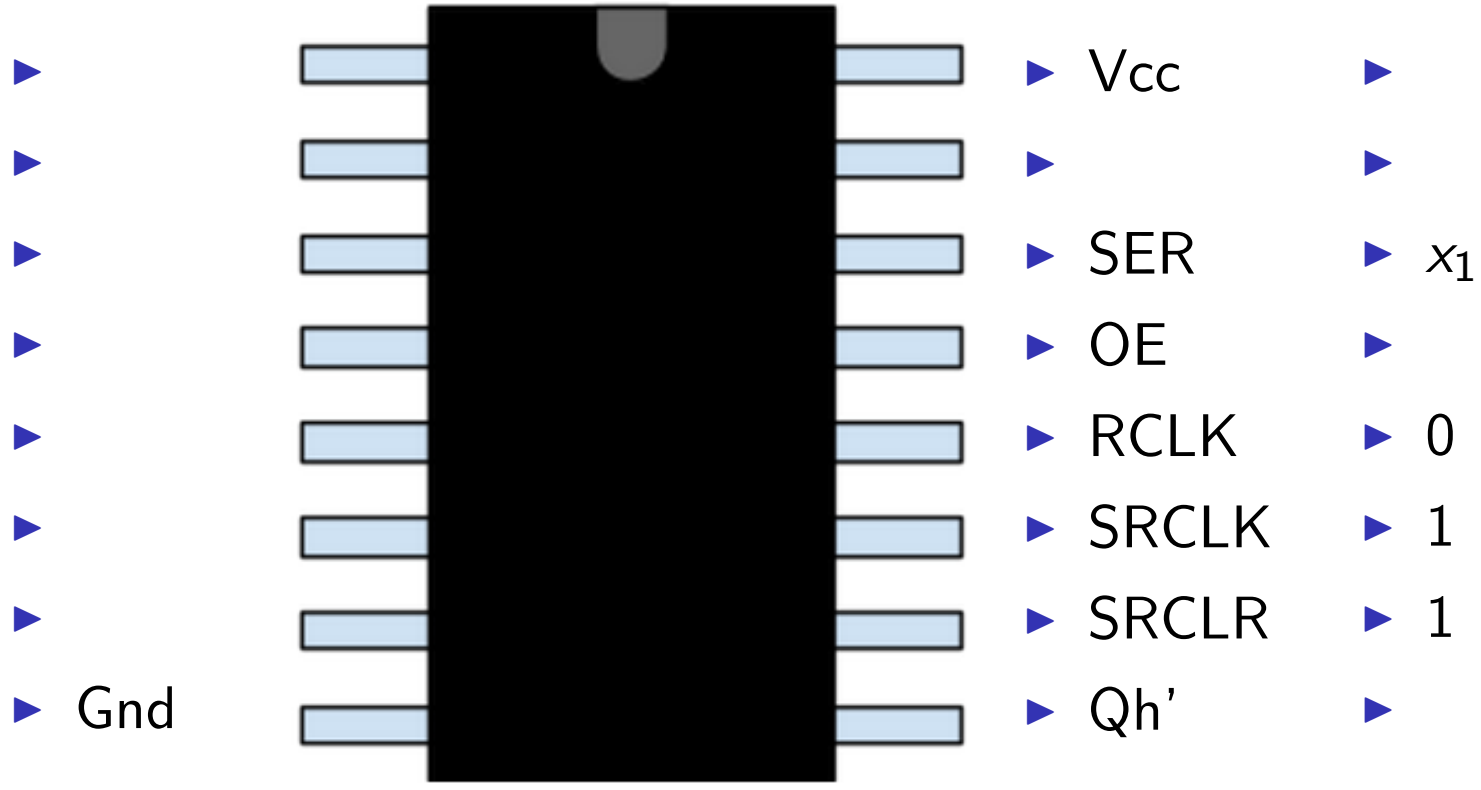
"Shift" Register



"Storage" Register



Shift Registers

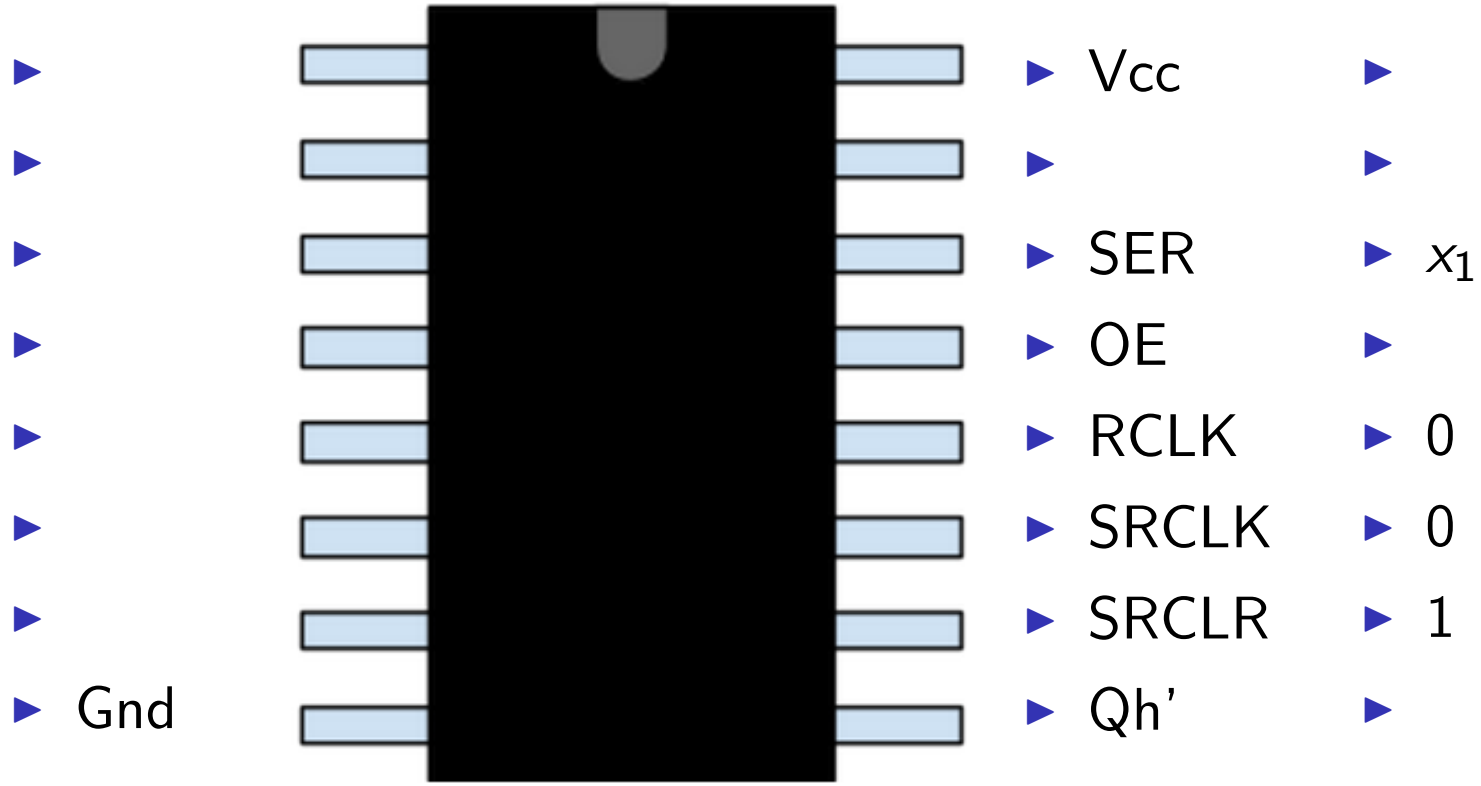


"Shift" Register

x_1							

"Storage" Register

Shift Registers

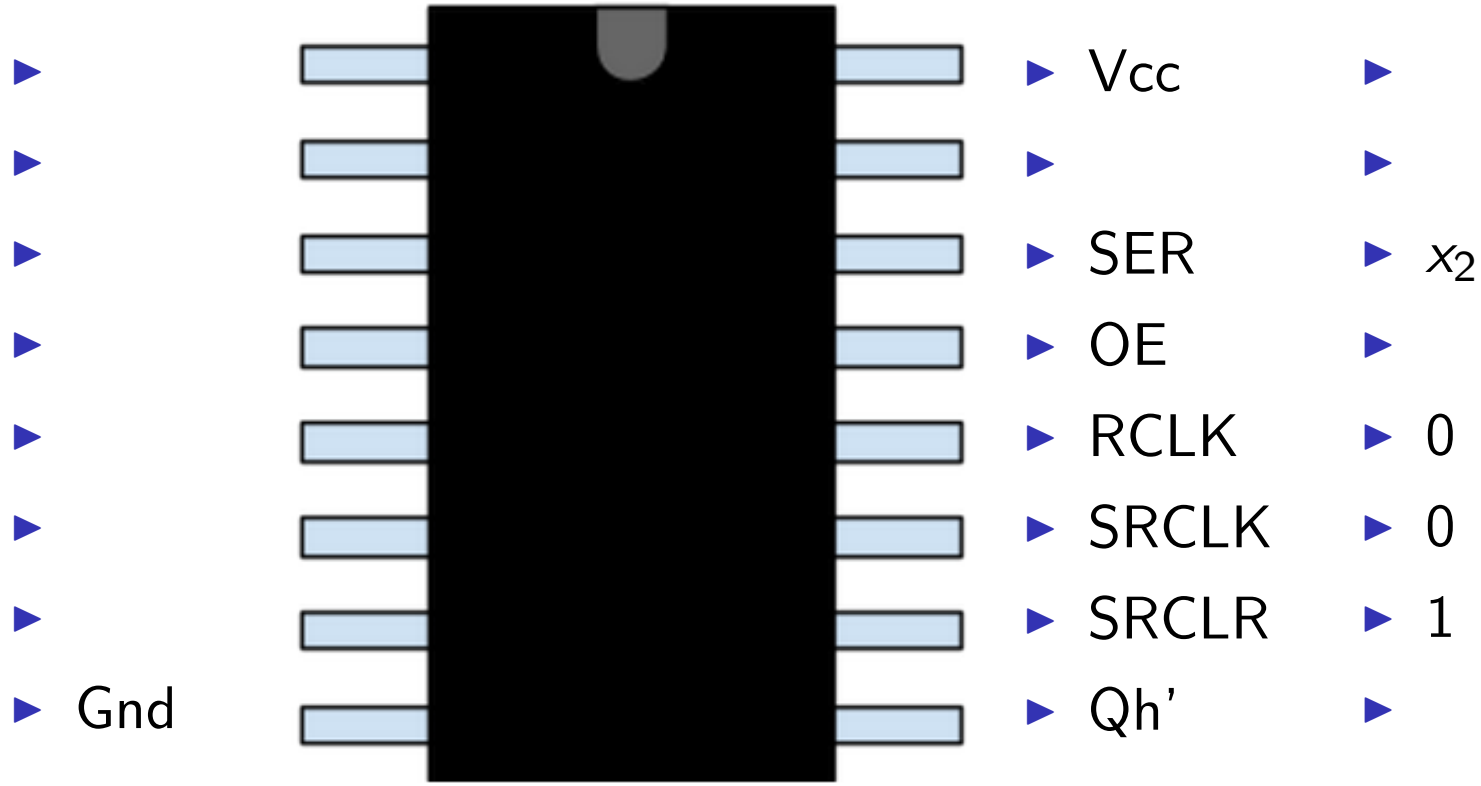


"Shift" Register

x_1							

"Storage" Register

Shift Registers

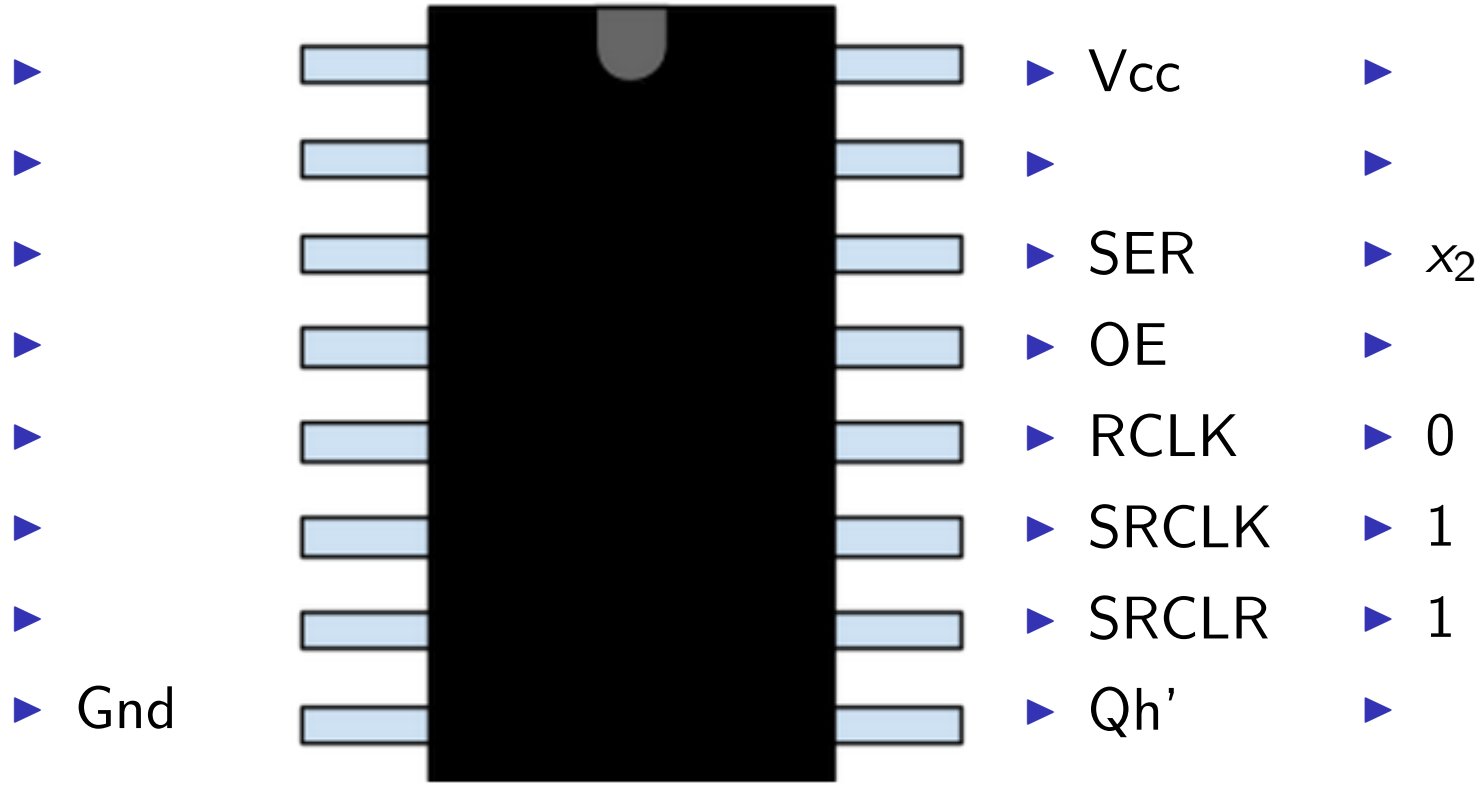


"Shift" Register

x_1							

"Storage" Register

Shift Registers

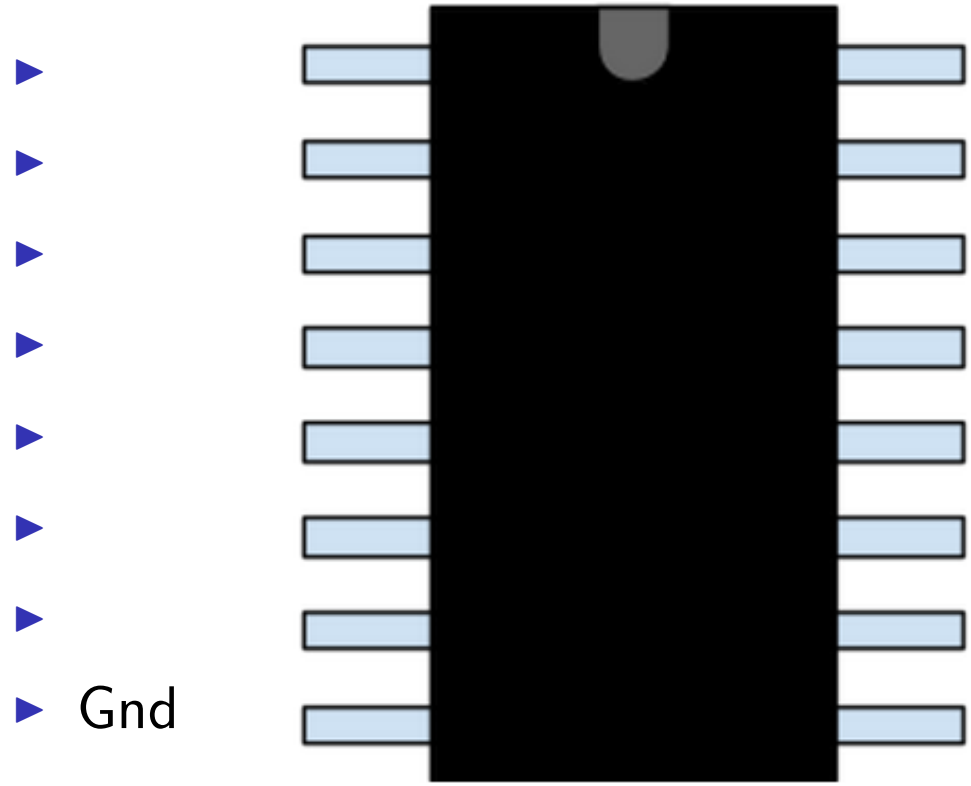


"Shift" Register

x_2	x_1						

"Storage" Register

Shift Registers

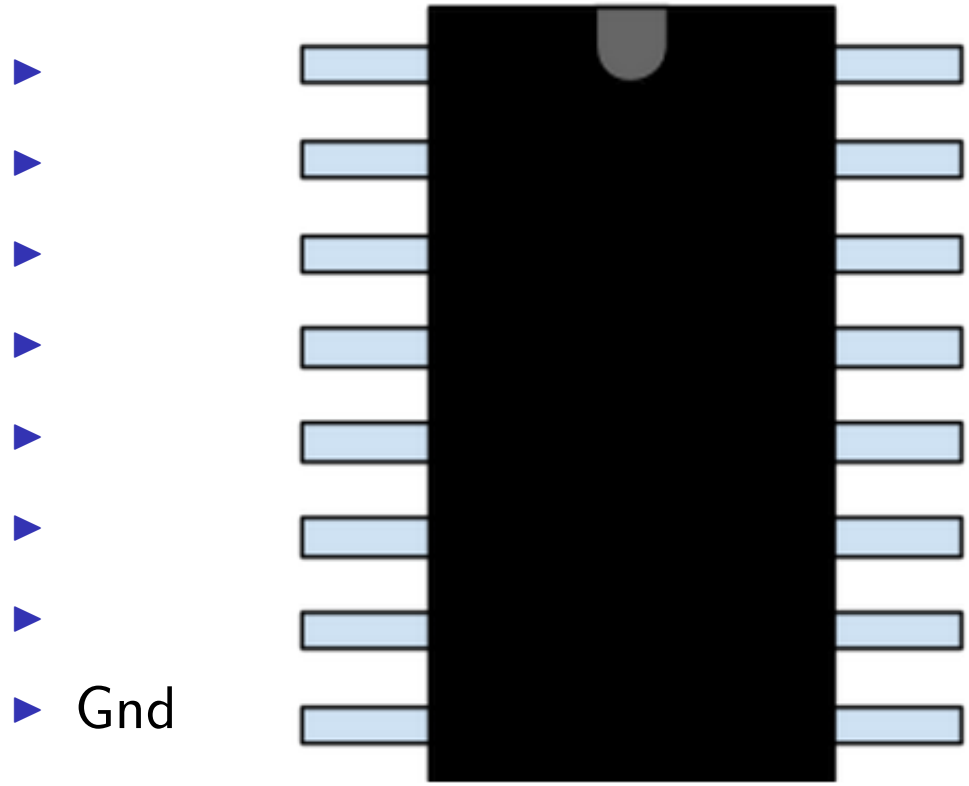


"Shift" Register

x_8	x_7	x_6	x_5	x_4	x_3	x_2	x_1

"Storage" Register

Shift Registers



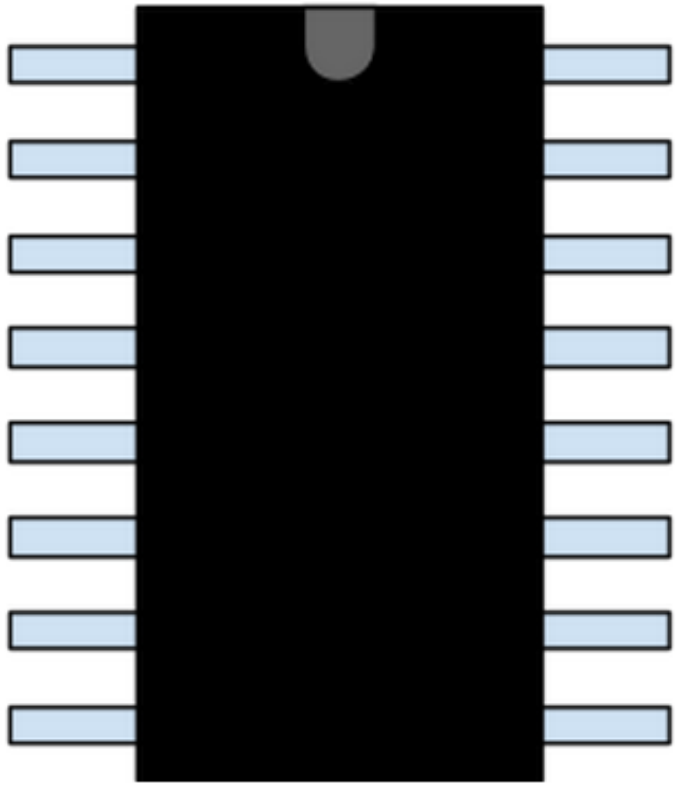
"Shift" Register

x_8	x_7	x_6	x_5	x_4	x_3	x_2	x_1

"Storage" Register

x_8	x_7	x_6	x_5	x_4	x_3	x_2	x_1

Shift Registers



- x_2
- x_3
- x_4
- x_5
- x_6
- x_7
- x_8
- Gnd
- Vcc
- x_1
- SER
- OE
- RCLK
- SRCLK
- SRCLR
- Qh'

- 0
- 1
- 1

"Shift" Register

x_8	x_7	x_6	x_5	x_4	x_3	x_2	x_1

"Storage" Register

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- The RGB LED Matrix can be run using 12 pins on the microcontroller
- If the RCLK and SRCLR are shared across all 4 shift registers 6 additional pins are saved
- The RGB LED Matrix can be run using only 6 pins of the microcontroller, without daisy chains