North Carolina State University
Tapestry Workshop
July 18, 2012

COMPUTER SCIENCE Unplugged

By Tim Bell, Ian Witten and Mike Fellows

And kinesthetic computer science activities

Lynn Lambert, Associate Chair
Physics, Computer Science and Engineering
Christopher Newport University
Newport News, Virginia

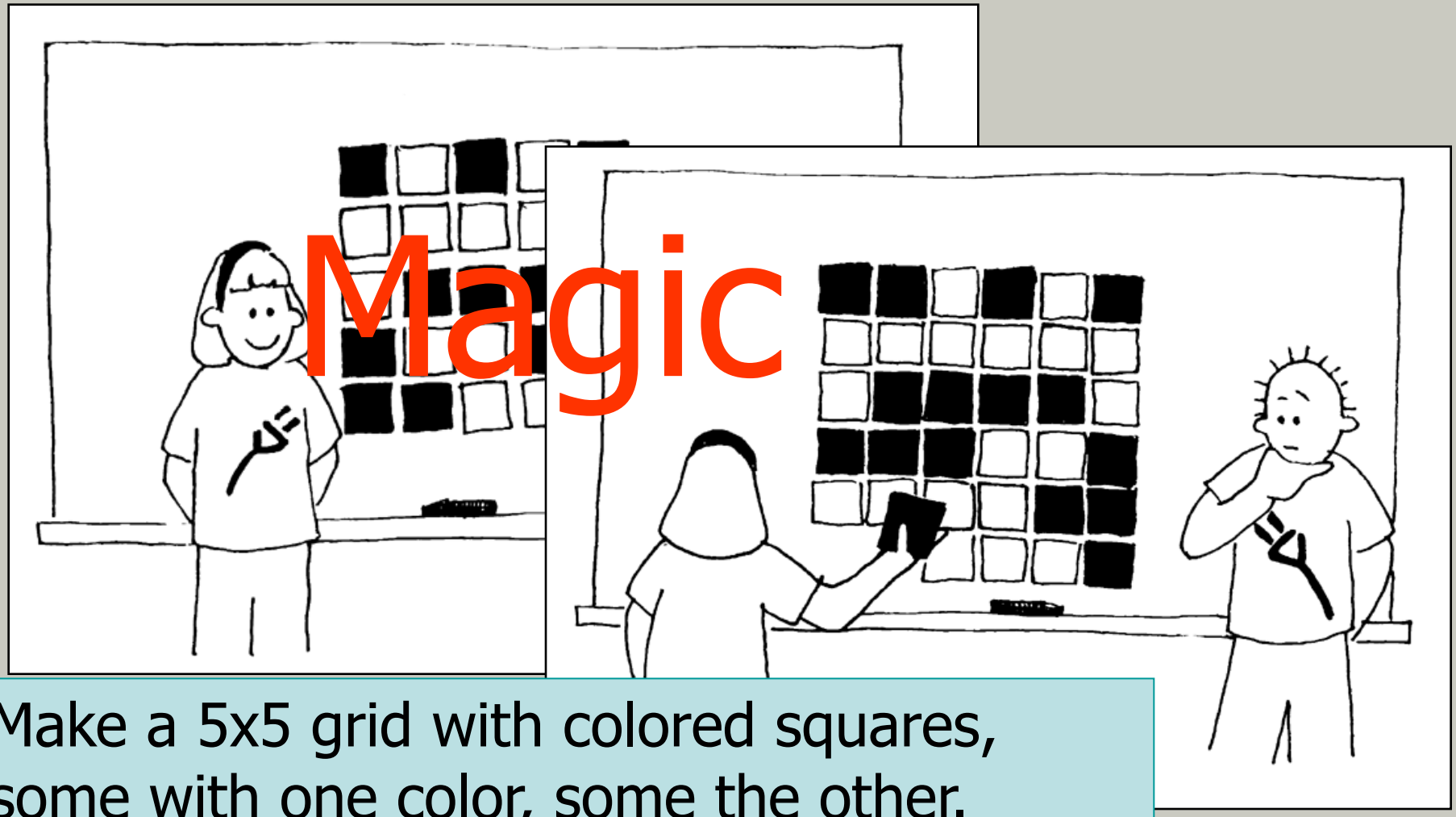
What is Unplugged

How to teach important computer science without using computers at all!

Like?

- Binary Numbers
- Image Representation
- Error Detection and Correction
- Text Compression
- Searching Algorithms
- Sorting Algorithms
- Sorting Networks
- Minimal Spanning Trees
- Routing and Deadlock
- Finite-state Automata
- Programming Languages
- Information Theory
- Public/Private Key

Magic Trick



Make a 5x5 grid with colored squares, some with one color, some the other.

Parity Checking

- ISBN-10 detects adjacent swapped digits or a single incorrect digit
- $X_{10} = (1x_1 + 2x_2 + 3x_3 + 4x_4 + 5x_5 + 6x_6 + 7x_7 + 8x_8 + 9x_9) \bmod 11$
- *Hunger Games* by Suzanne Collins: 0-439-02348-3
- 1*0 + 2*4 + 3*3 + 4*9 + 5*0 + 6*2 + 7*3 + 8*4 + 9*8
- 0 + 8 + 9 + 36 + 0 + 12 + 21 + 32 + 27 = 145
- 190 mod 11 = 3

Binary Digits

Characters Stored as Binary Numbers

0	1	2	3	4
Blank	A	B	C	D

5	6	7	8	9	10
E	F	G	H	I	J

11	12	13	14	15	16
K	L	M	N	O	P

17	18	19	20	21
Q	R	S	T	U

22	23	24	25	26
V	W	X	Y	Z

10011 S
10100
00001
01110
00100
00000
10101
10000

Characters and Binary

0	1	2	3	4
Blank	A	B	C	D

5	6	7	8	9	10
E	F	G	H	I	J

11	12	13	14	15	16
K	L	M	N	O	P

17	18	19	20	21
Q	R	S	T	U

22	23	24	25	26
V	W	X	Y	Z

10011	S
10100	T
00001	A
01110	N
00100	D
00000	
10101	U
10000	P

Characters and Sound Represented in Binary

1	2	3	4	5	6	7	8	9	10	11	12	13
A	B	C	D	E	F	G	H	I	J	K	L	M
14	15	16	17	18	19	20	21	22	23	24	25	26
N	O	P	Q	R	S	T	U	V	W	X	Y	Z

8 9

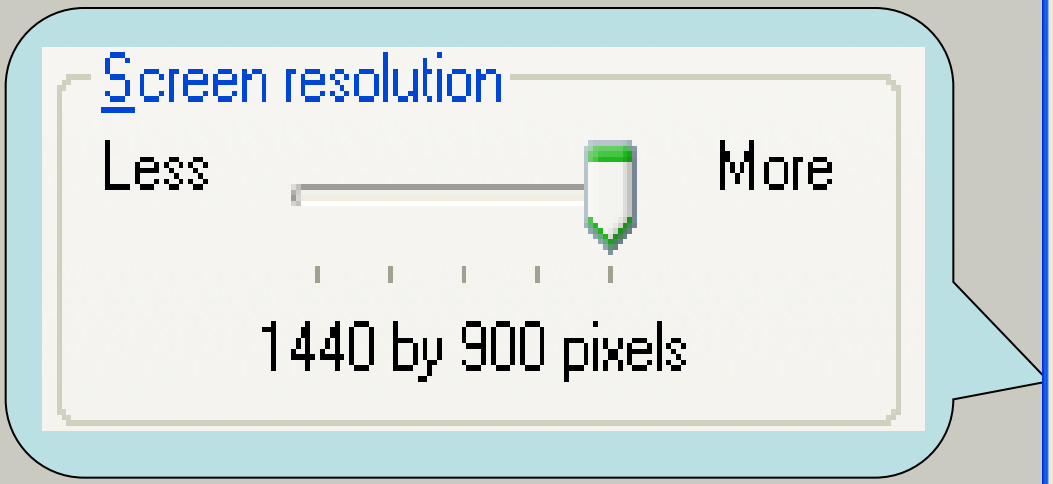
01000 01001

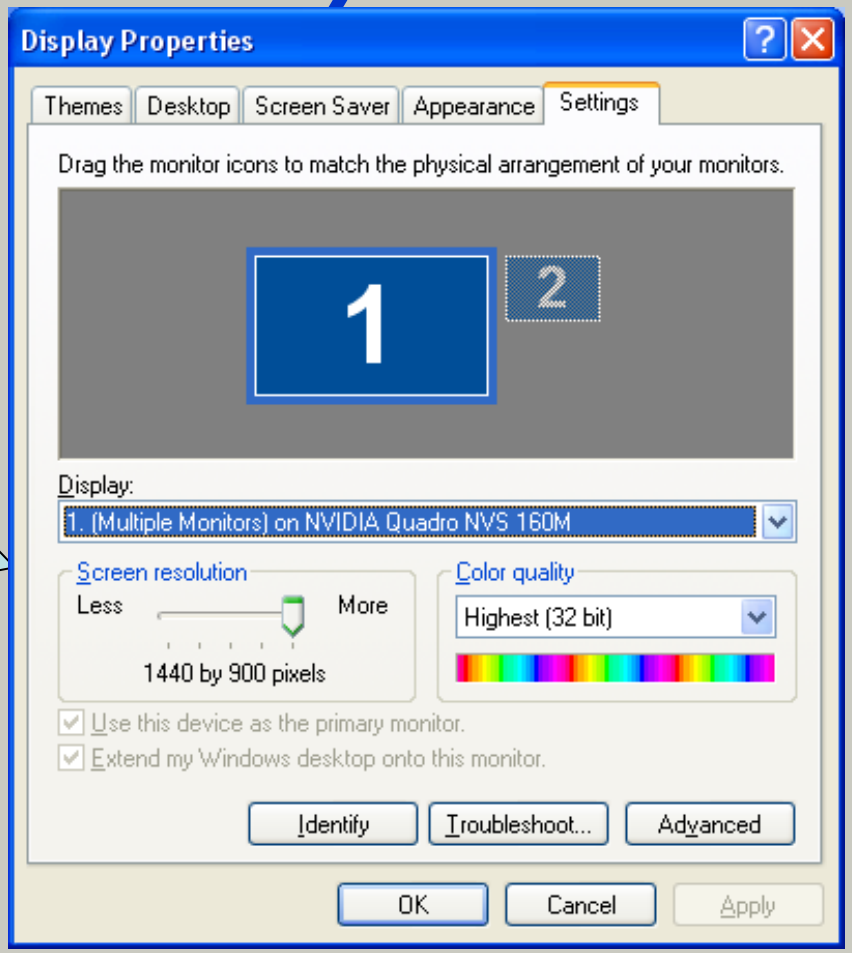
2 25 5

00010 11001 00101

Image Representation (black and white)

- Each pixel is a bit





1440 * 900 =
1,296,000 pixels (bits)

Image Representation

Row 1	**0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0**
Row 2	
Row 3	
Row 4	
Row 5	
Row 6	
Row 7	
Row 8	
Row 9	

Image Representation (black and white)

- Each pixel is a bit
- 0000111111111100 for first row
- etc.

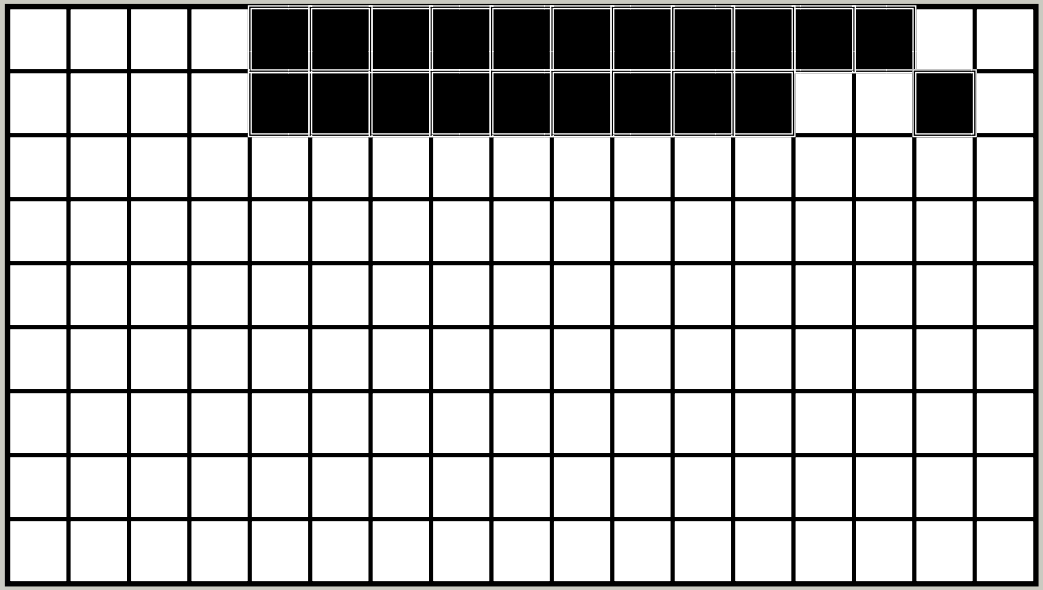


Image Representation

Row 1	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 2	**0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0**
Row 3	
Row 4	
Row 5	
Row 6	
Row 7	
Row 8	
Row 9	

Image Representation

Row 1	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 2	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 3	**0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0**
Row 4	
Row 5	
Row 6	
Row 7	
Row 8	
Row 9	

Image Representation

Row 1	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 2	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 3	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 4	**0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0**
Row 5	
Row 6	
Row 7	
Row 8	
Row 9	

Image Representation

Row 1	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 2	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 3	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 4	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 5	**0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0**
Row 6	
Row 7	
Row 8	
Row 9	

Image Representation

Row 1	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 2	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 3	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 4	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 5	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0
Row 6	**0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0**
Row 7	
Row 8	
Row 9	

Image Representation

Row 1	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 2	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 3	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 4	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 5	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0
Row 6	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0
Row 7	0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0
Row 8	**1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1**
Row 9	

Image Representation

Row 1	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 2	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 3	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0
Row 4	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0
Row 5	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0
Row 6	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0
Row 7	0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0
Row 8	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
Row 9	**0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0**

Image Representation

Row 1	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0	4, 11, 2
Row 2	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0	4, 9, 2, 1, 1
Row 3	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0	4, 9, 2, 1, 1
Row 4	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0	4, 11, 2
Row 5	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0	4, 9, 4
Row 6	0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0	4, 9, 4
Row 7	0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0	5, 7, 5
Row 8	1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1	0, 17
Row 9	0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0	1, 15, 1

Image Compression
Run Length Encoding

4, 11, 2
4, 9, 2, 1, 1
4, 9, 2, 1, 1
4, 11, 2
4, 9, 4
4, 9, 4
5, 7, 5
0, 17
1, 15, 1

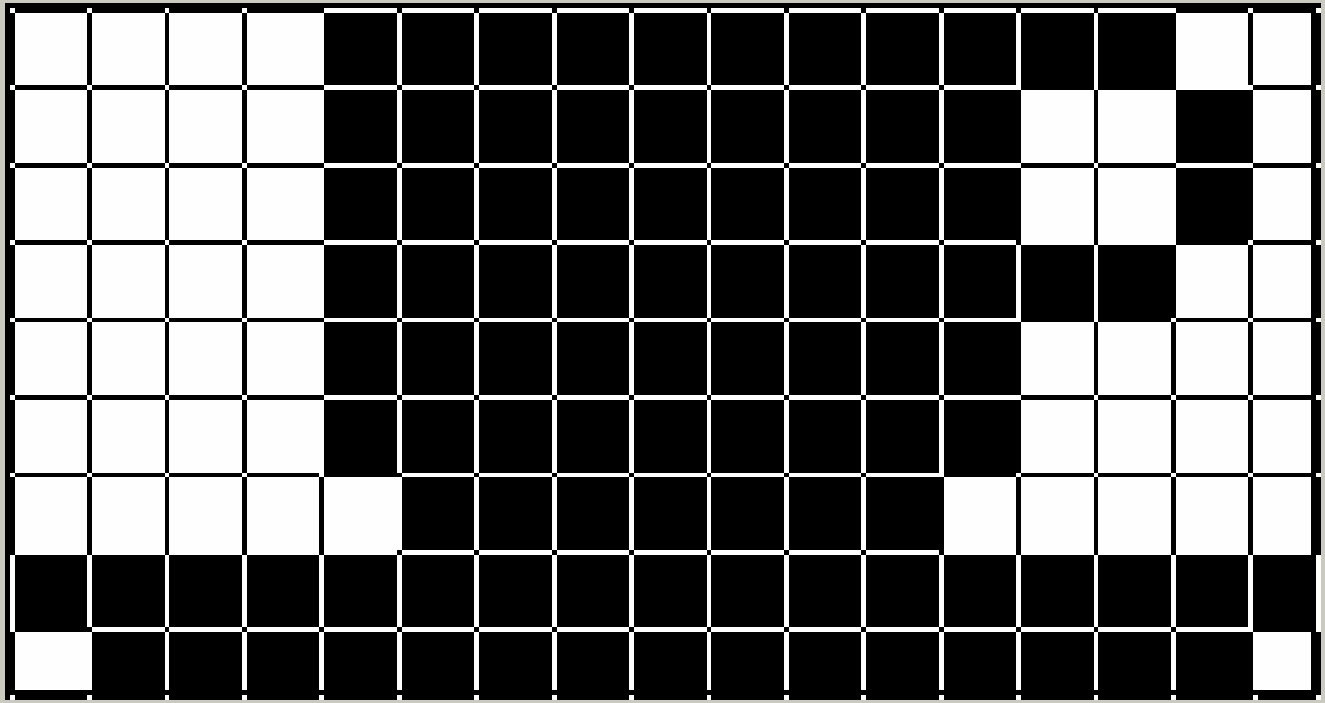
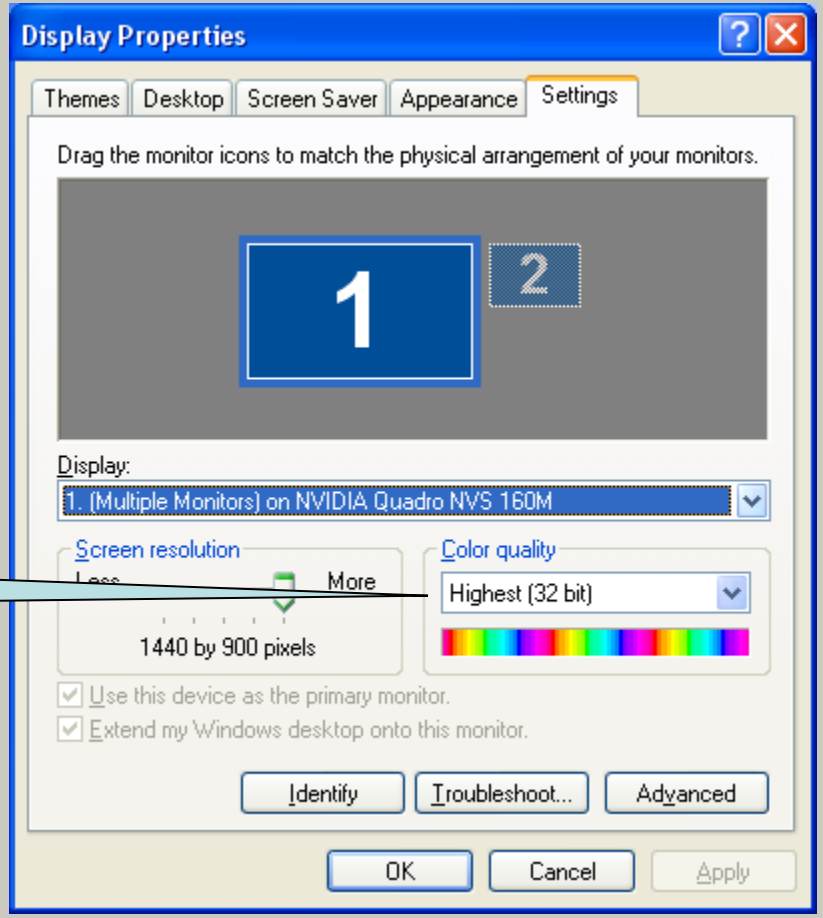


Image Representation (Color)

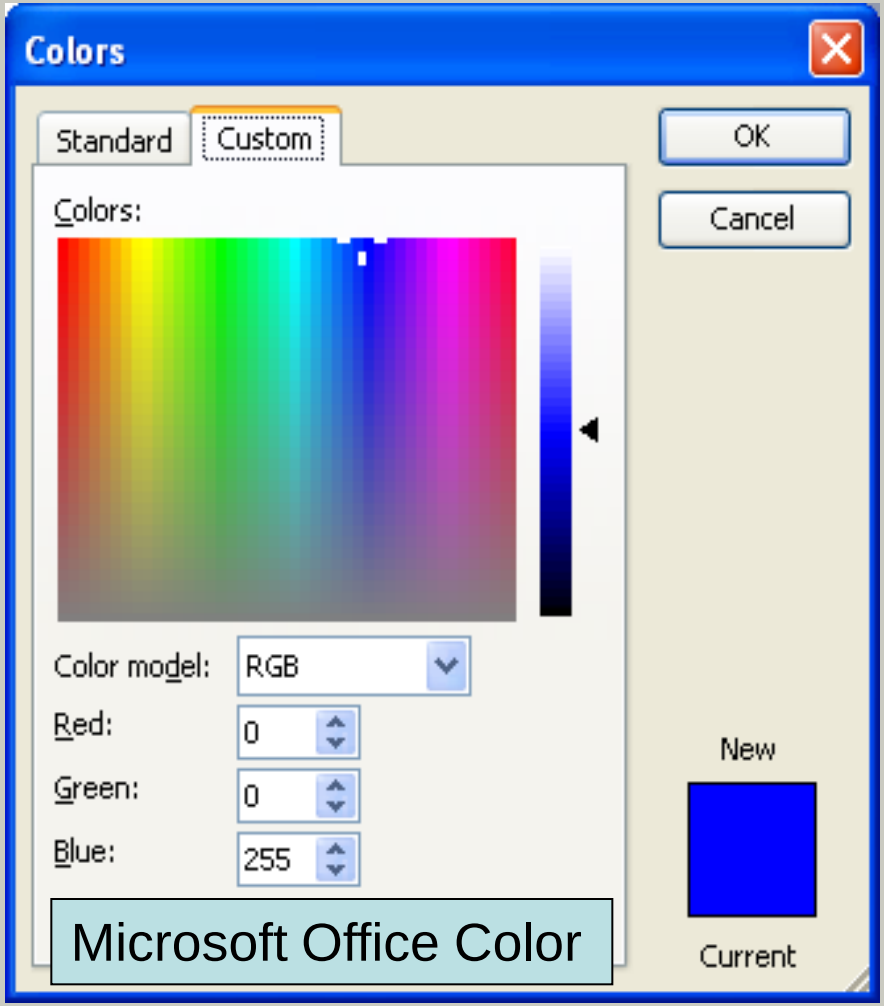
- Each pixel is a bit
- Still 1,296,000 pixels
- Now, each pixel is

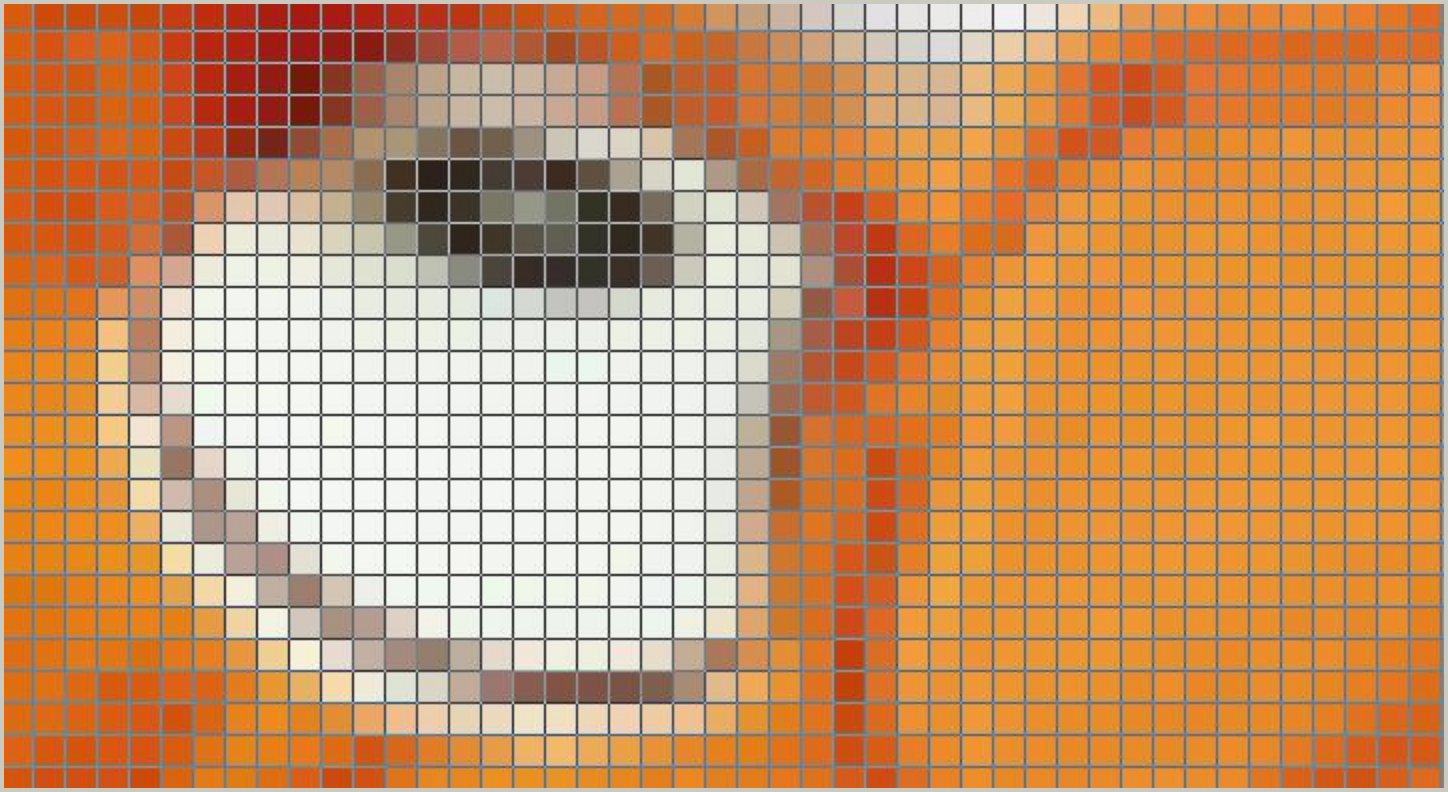
32 bits

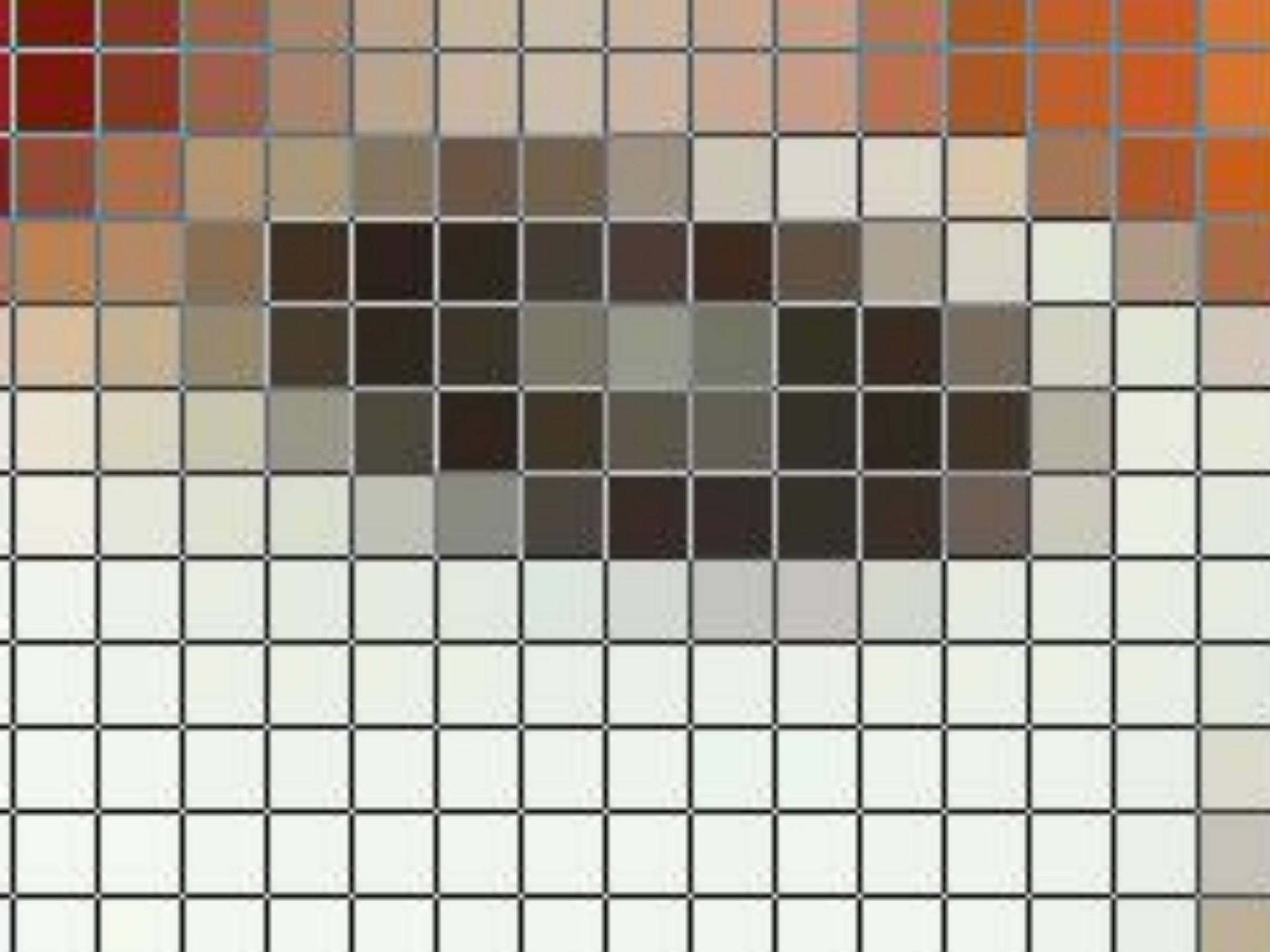


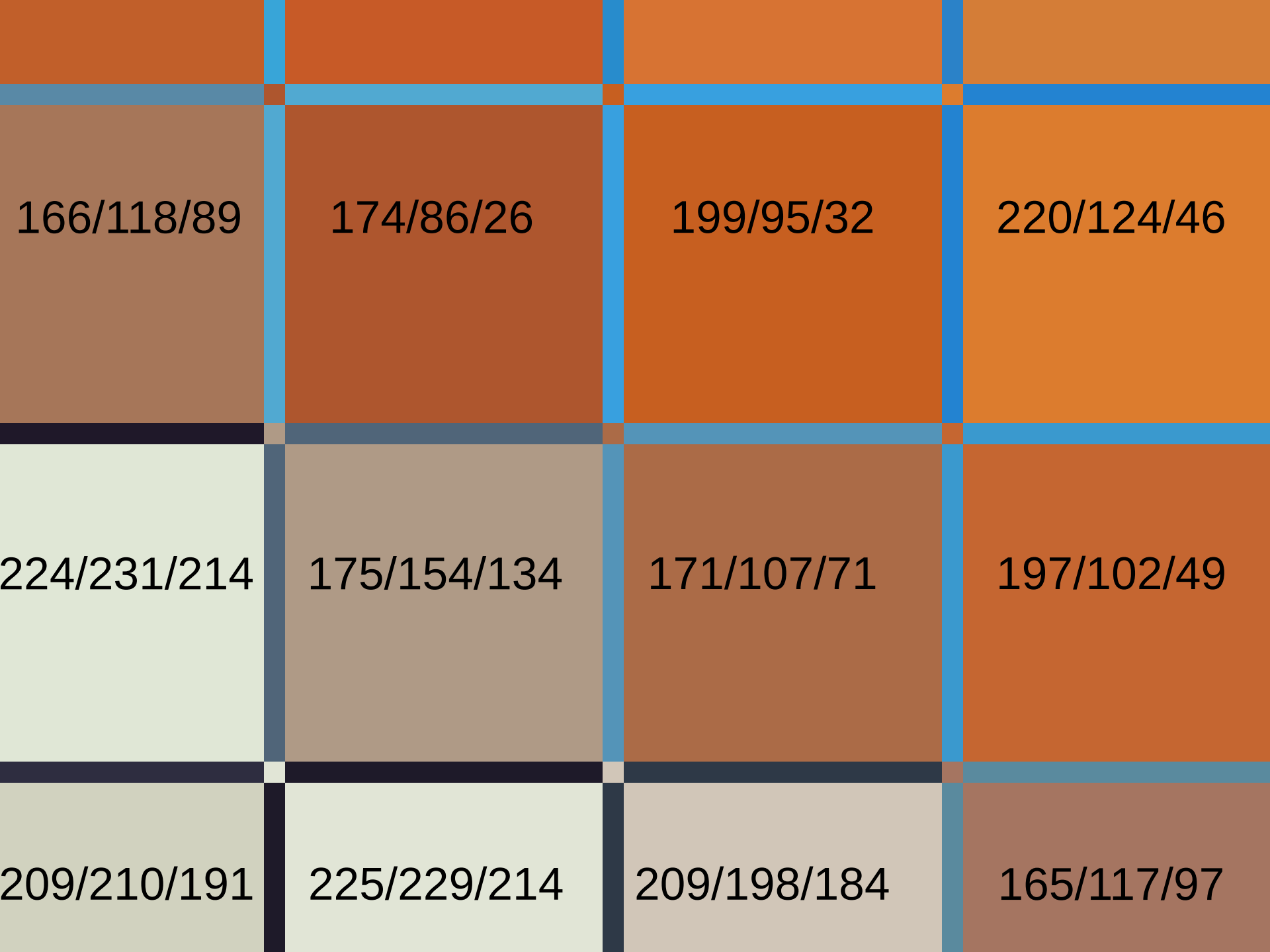
Color Images

- RGB color
  - 0 0 255 for blue
  - 00000000
  - 00000000
  - 11111111








166/118/89
174/86/26
199/95/32
220/124/46
224/231/214
175/154/134
171/107/71
197/102/49
209/210/191
225/229/214
209/198/184
165/117/97

Non CSUnplugged Activities

- Andy Begel, Steve Wolfman, Dan Garcia KLA (Kinesthetic Learning Activities), http://ws.cs.ubc.ca/~kla/,
  - Binary Tree
  - Recursion
  - cons, car, cdr

- AP Reading Toy Night with Robert Duvall
- AP list, CSTA, SIGCSE, colleagues

Non CSUnplugged Activities

- Web Page for CSTA: http://www.csta.acm.org/

- Membership is FREE!!!

Have you used Unplugged or unplugged like activities? How?

Some Unplugged Activities

- **Binary Numbers**
- **Error Detection and Correction**
- **Image Representation**
- Text Compression
- Searching Algorithms
- Sorting Algorithms
- Sorting Networks
- Minimal Spanning Trees
- Routing and Deadlock
- Finite-state Automata
- Programming Languages
- Information Theory
- Public/Private Key