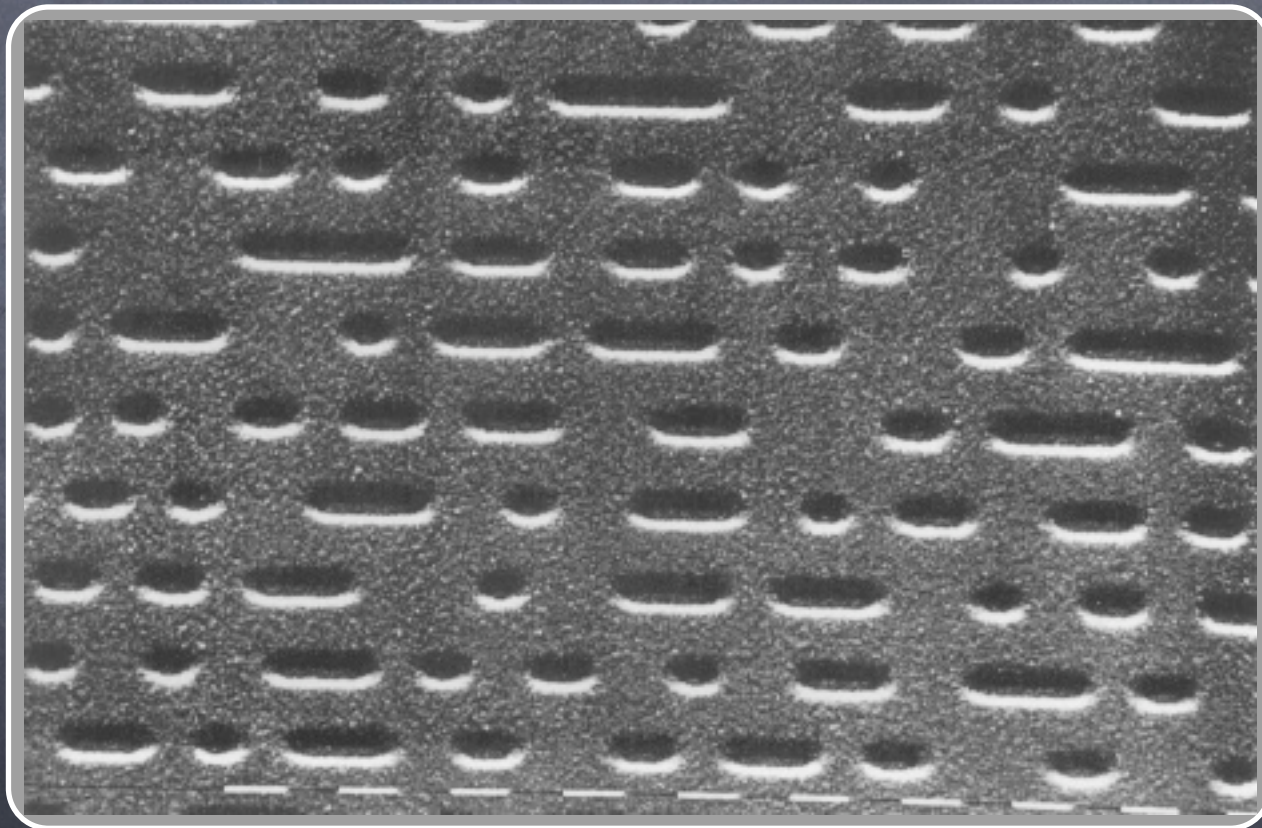
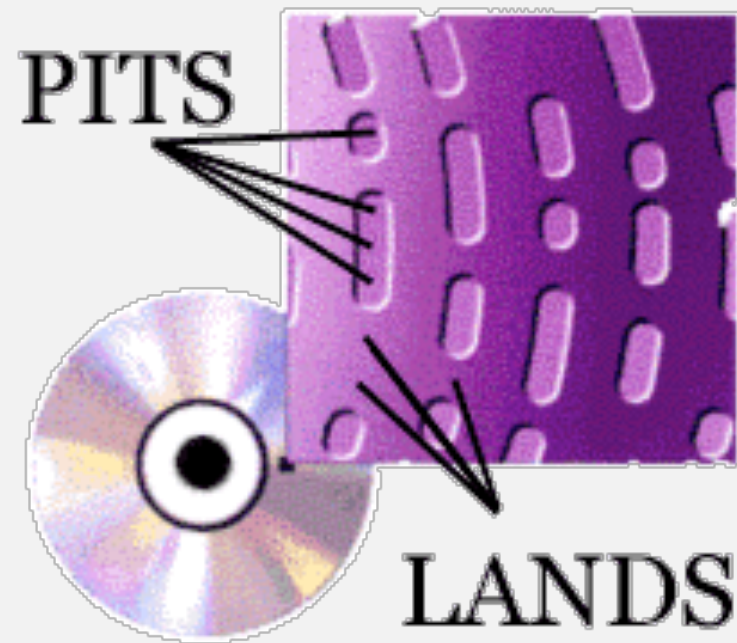


Any Guesses?



CD/DVD Encoding



"I called my brothel Friday night."

ASCII codes for r and l:

l = 01101100

r = 01101010

"I wanted to see how he was doing
after his surgery."

Redundancy

brothea, brotheb, brothec, brothed, brothee,
brothef, brotheg, brotheh, brothei, brothej,
bothek, brothem, brothen, brotheo, brothep,
brotheq, brothes, brothet, brotheu, brothev,
brothew, brothex, brothey, brothez

another baother brather broaher brotaer brothar brothea brother bbrother brbther
brobher brotber brothbr brotheb crother bcother brcther brocher brotcer brothcr
brothec drother bdoother brdther brodher brotder brothdr brothed erother beother
brether broeher broteer brother brothee frother bfother brfther brofher brotfer
brothfr brothef grother bgoother brgther brogher brotger brothgr brotheg hrother
bhoother brhther brohher brother brothhr brotheh irother biother brither broiher
brotier brothir brothei jrother bjother brjther brojher brotjer brothjr brothej
krother bkother brkther brokher brotker brothkr brothek lrother blother brlther
brother brotler brothlr **brothel** mrother bmother brmther bromher brotmer brothmr
brothem nrother bnoother brnther bronher brotner brothnr brothen orother boother
brother brooher brotoer brothor brotheo prother bpoother brpther bropher brotper
brothpr brothep qrother bqother brqther broqher brotqer brothqr brotheq rrother
brother brrther brorher brotrer brothrr **brother** srother bsother brsther brosher
brotser brothsr brothes trother btother brttther brother brotter brothtr brothet
urother buother bruther brouher brotuer brothur brotheu vrother bvother brvther
brovher brotver brothvr brothev wrother bwother brwther browher brotwer brothwr
brothew xrother bxother brxther broxher brotxer brothxr brothex yrother byother
bryther broyher brotyer brothyr brothey zrother bzother brzther brozher brotzer
brothzr brothez

Class of 60s Talk, 2:35 here.
(snacks upstairs at 2:15)

Last Homework!

Writable CDs?

ReWritable CDs?

Parity Bits

0	1	0	1	0	0	0	1
---	---	---	---	---	---	---	---

message
bits

Parity Bits



message
bits

parity
bit

Sum of message bits + parity bit must be EVEN

(increases transmission size by 11%)

Parity Bits

Trasmitted:

0	1	0	1	0	0	0	1	1
---	---	---	---	---	---	---	---	---

Received:

0	1	0	1	1	0	0	1	1
---	---	---	---	---	---	---	---	---

ok?

Parity Bits

Transmitted:

0	1	0	1	0	0	0	1	1
---	---	---	---	---	---	---	---	---

Received:

0	1	0	1	1	0	0	1	1
---	---	---	---	---	---	---	---	---

ok?

Received:

0	1	0	1	0	0	0	1	0
---	---	---	---	---	---	---	---	---

ok?

Parity Bits

Transmitted:

0	1	0	1	0	0	0	1	1
---	---	---	---	---	---	---	---	---

Received:

0	1	0	1	1	0	0	1	1
---	---	---	---	---	---	---	---	---

ok? No

Received:

0	1	0	1	0	0	0	1	0
---	---	---	---	---	---	---	---	---

ok? No

Received:

0	0	0	0	0	0	0	1	1
---	---	---	---	---	---	---	---	---

ok? Yes?

Transmitting Large Messages

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

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

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

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

Burst Errors

0	1	1	0	1	0	0	1	0	0	1	0	1	0	0	0	1	1	0	1	0	0	0	0	1	1	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

becomes

[illegible]

Burst Errors

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

becomes

0 1 1 0 1 0 0 1 0 ? ? ? ? ? ? ? ? ? 0 1 0 0 0 0 1 1 1

$P(\text{undetected 1-byte burst error}) = ?$

Burst Errors

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

becomes

0 1 1 0 1 0 0 1 0 ? ? ? ? ? ? ? ? ? 0 1 0 0 0 0 1 1 1

$$P(\text{undetected 1-byte burst error}) = 1/2$$

Burst Errors

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

becomes

0 1 1 ? 1 1 1

$P(\text{undetected 5-byte burst error}) = ?$

Burst Errors

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

becomes

0 1 1 ? 1 1 1

$$P(\text{undetected 5-byte burst error}) = (1/2)^5$$

Transmitting Large Messages

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

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

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

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

Vertical Parity

0	1	1	0	1	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	1	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

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

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

0	1	1	0	1	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

(increases transmission size by w bits)

Vertical Parity & Burst Errors

b = length of burst

w = width of message

0	1	1	0	1	0	?	?
?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1
0	1	1	1	1	0	1	1

$P(\text{undetected error}) = ?$

Vertical Parity & Burst Errors

if $b \leq w$:

0	1	1	0	1	0	0	1
0	1	0	?	?	?	?	?
?	?	0	0	0	0	1	1
0	1	1	1	1	0	1	1

$P(\text{undetected error}) = ?$

Vertical Parity & Burst Errors

if $b \leq w$:

0	1	1	0	1	0	0	1
0	1	0	?	?	?	?	?
?	?	0	0	0	0	1	1
0	1	1	1	1	0	1	1

$$P(\text{undetected error}) = 0$$

Vertical Parity & Burst Errors

if $b > w$:

0	1	1	0	1	0	?	?
?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1
0	1	1	1	1	0	1	1

$P(\text{undetected error}) = ?$

Vertical Parity & Burst Errors

if $b > w$:

0	1	1	0	1	0	?	?
?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1
0	1	1	1	1	0	1	1

$$P(\text{undetected error}) = 1/2^w - 1/2^b$$

Vertical Parity & Burst Errors

0	1	1	0	1	0	?	?
?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1
0	1	1	1	1	0	1	1

$$P(\text{undetected error}) = \frac{1}{2^w} - \frac{1}{2^b}$$

w	b	P(...)
8	16	10^{-3}
16	32	10^{-5}
64	128	10^{-20}
256	512	10^{-78}

Vertical Parity & Burst Errors

Medium burst?

0	1	1	0	1	0	0	1
0	1	0	?	?	?	?	?
?	?	?	?	?	?	1	1
0	1	1	1	1	0	1	1

$$P(\text{undetected error}) = 1/2^w - 1/2^b$$

2 Dimensional Parity

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

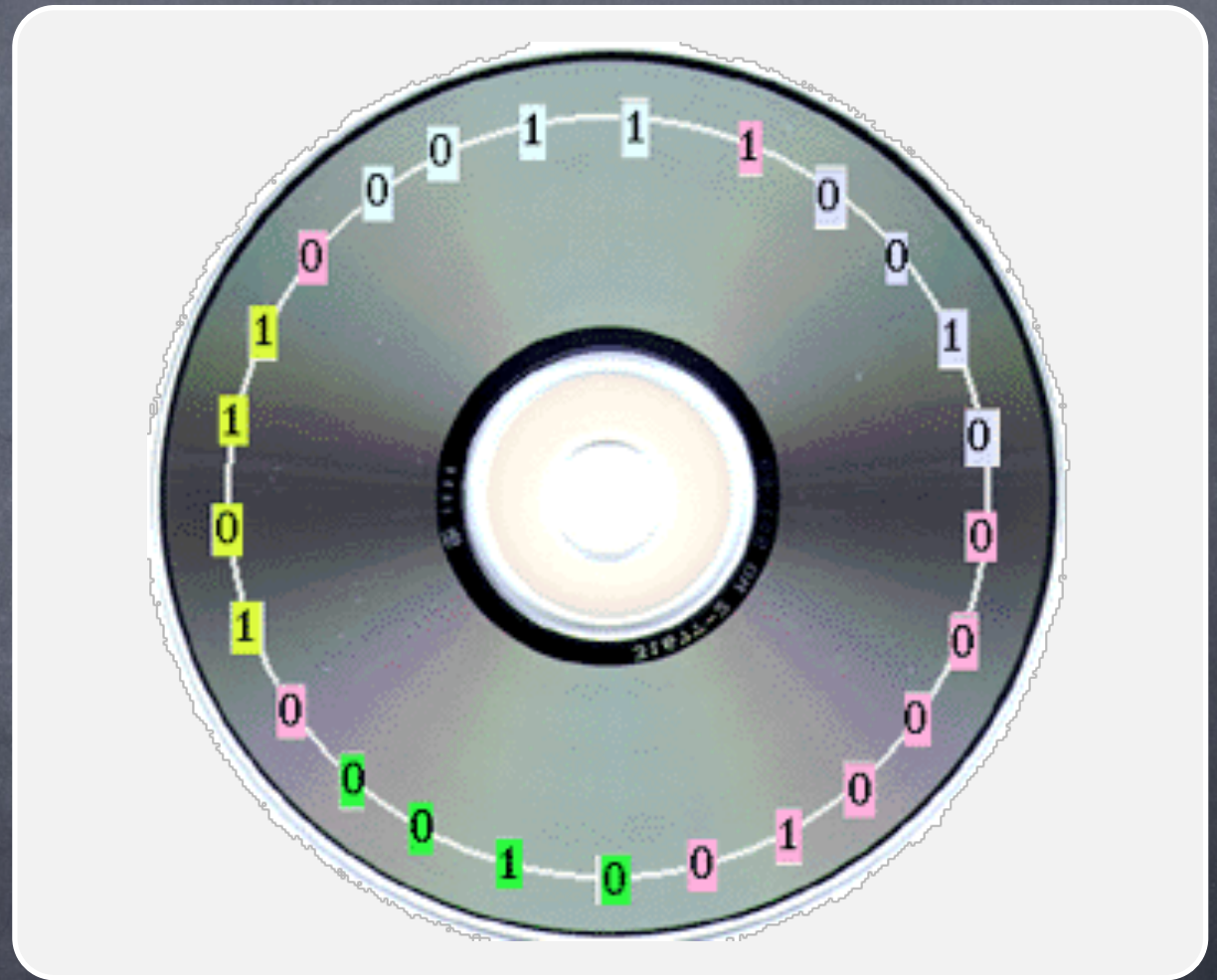
0 1 1 0 1 0 0 1
0 1 0 1 0 0 0 1
0 1 0 0 0 0 1 1

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

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

Spatial Interleaving

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

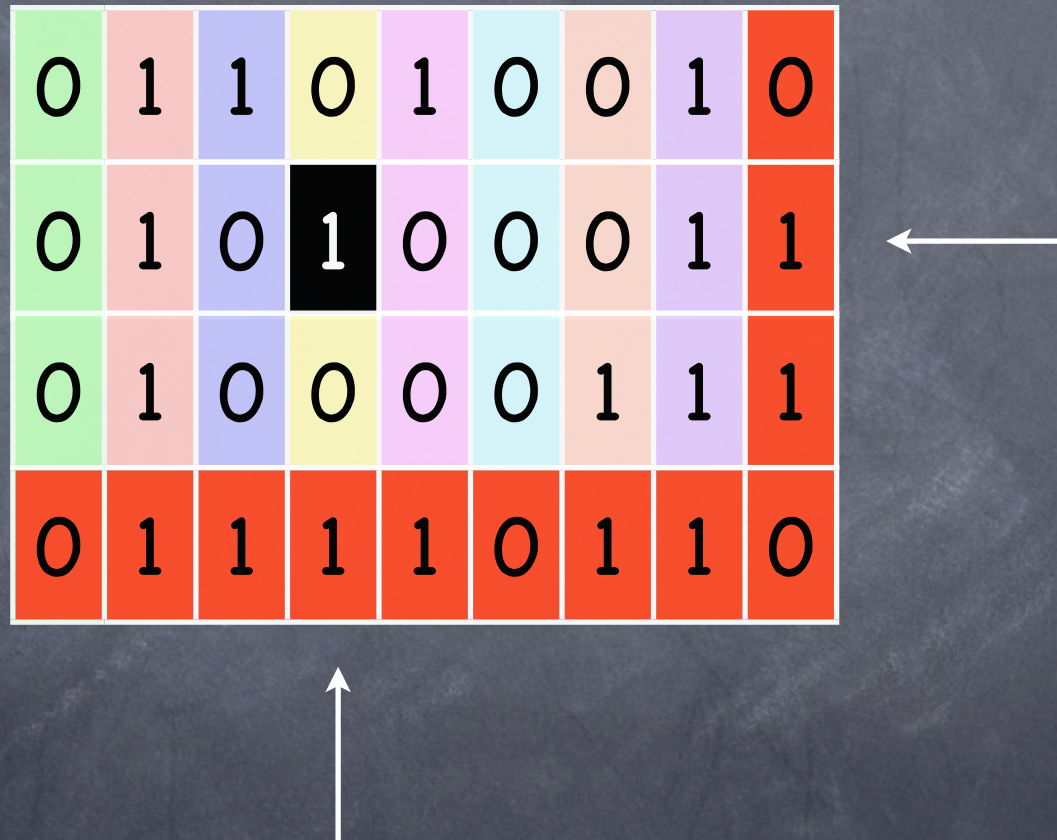


Error Correction

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

Error Correction: 1-Bit Error

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

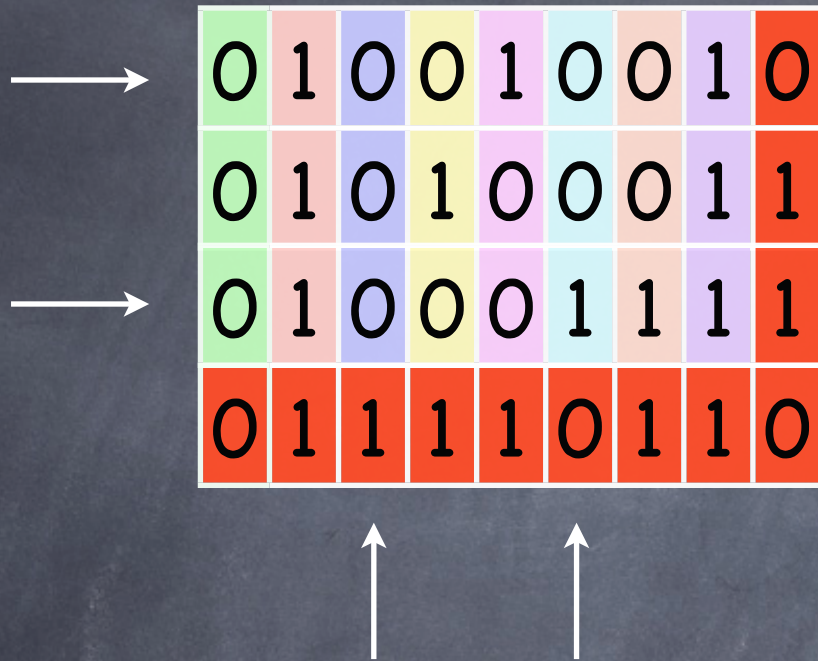


The diagram illustrates a 4x9 grid of bits. The grid is organized into four rows and nine columns. The bits are as follows:

- Row 1: 0, 1, 1, 0, 1, 0, 0, 1, 0
- Row 2: 0, 1, 0, 1, 0, 0, 0, 1, 1
- Row 3: 0, 1, 0, 0, 0, 0, 1, 1, 1
- Row 4: 0, 1, 1, 1, 1, 0, 1, 1, 0

The cell containing the bit '1' in the second row, fourth column is highlighted in black, indicating a 1-bit error. A horizontal arrow points to this cell from the right, and a vertical arrow points to it from the bottom.

Error Correction: 2-Bit Error



A 4x9 grid of bits is shown. The columns are color-coded: Column 1 is green, Column 2 is light red, Column 3 is light blue, Column 4 is yellow, Column 5 is pink, Column 6 is light cyan, Column 7 is light orange, Column 8 is light purple, and Column 9 is red. Two horizontal arrows point to the first and third rows. Two vertical arrows point to the third and fifth columns. The grid contains the following bits:

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

Error Correction: 2-Bit Error

→

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

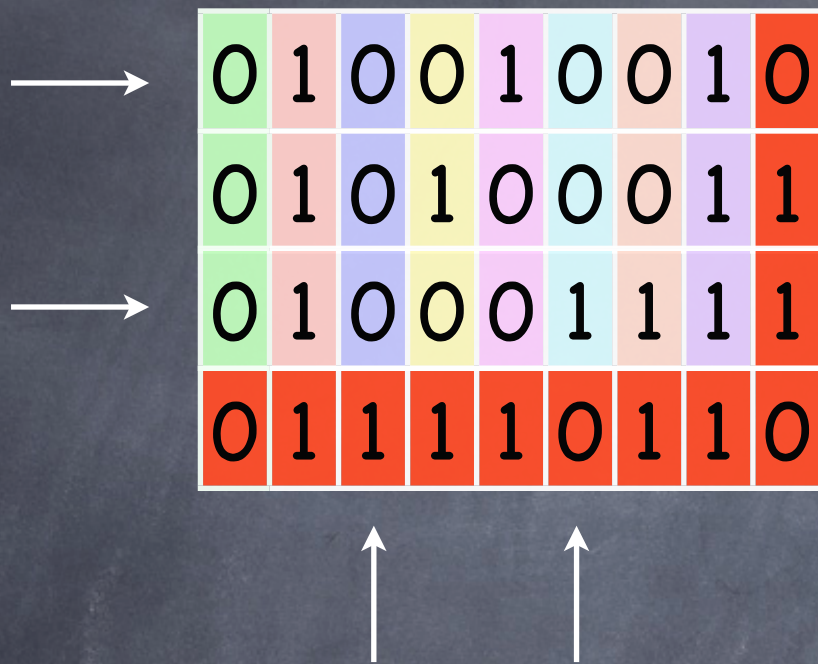
↑ ↑

→

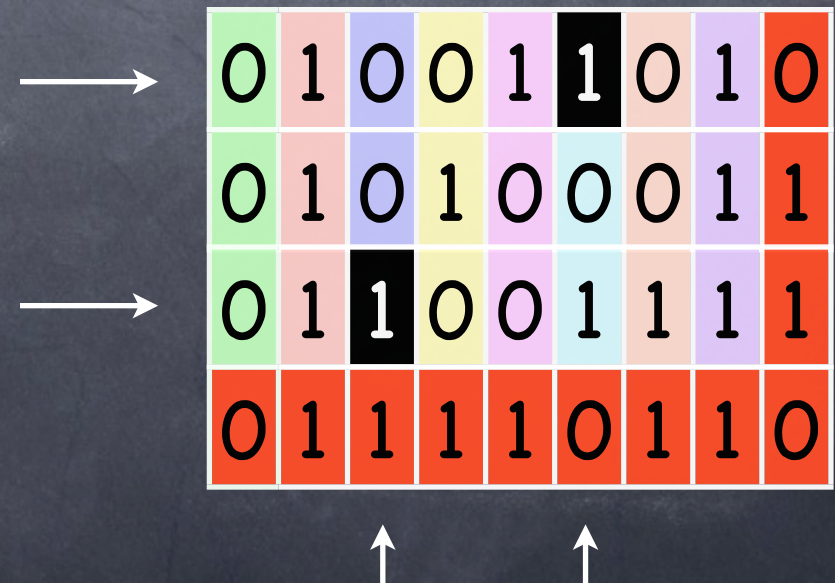
0	1	1	0	1	0	0	1	0
0	1	0	1	0	0	0	1	1
0	1	0	0	0	0	1	1	1
0	1	1	1	1	0	1	1	0

↑ ↑

Error Correction: 2-Bit Error



→	0	1	0	0	1	0	0	1	0
	0	1	0	1	0	0	0	1	1
→	0	1	0	0	0	1	1	1	1
	0	1	1	1	1	0	1	1	0



→	0	1	0	0	1	1	0	1	0
	0	1	0	1	0	0	0	1	1
→	0	1	1	0	0	1	1	1	1
	0	1	1	1	1	0	1	1	0

2-Bit Errors: Detect But Can't Correct...

→

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

↑ ↑

→

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

↑ ↑

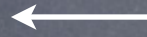
→

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

↑ ↑

Another Example

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



Another Example

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



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



Another Example

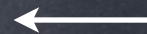
0	1	1	0	1	0	0	1	0
0	1	0	0	0	0	0	1	1
0	1	0	0	0	0	1	1	1
0	1	1	0	1	0	1	1	0



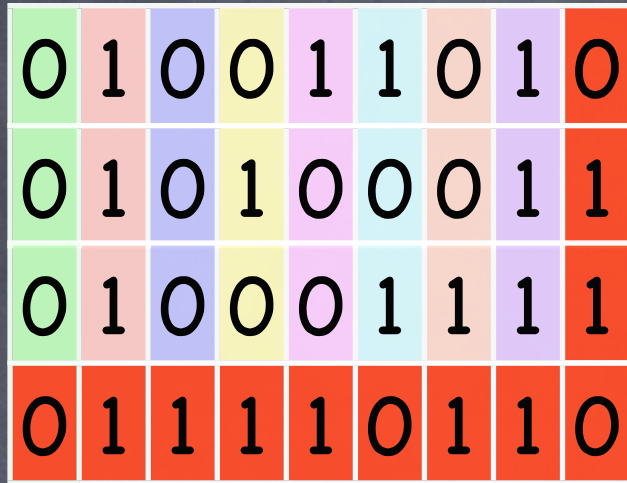
0	1	1	0	1	0	0	1	0
1	1	0	0	0	0	0	1	1
0	1	0	0	0	0	1	1	1
1	1	1	0	1	0	1	1	0



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



Last Example



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



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



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



3-Bit Errors: Detect but **Miscorrect!?!**



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



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



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

