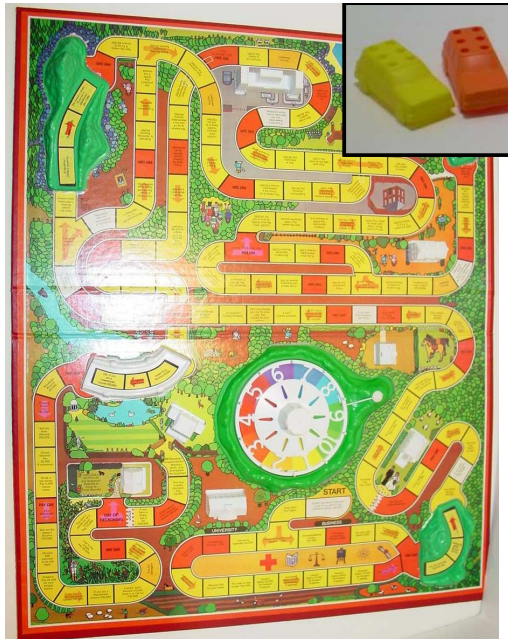
The CS 5 Enquirer

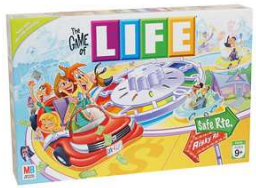
"DANCING WITH THE STARS" PENGUIN HAS LOVE CHILD!

Hollywood: Millions of Americans joined millions of Antarcticans in watching their newest idol, Fred "A Stare" Penguin, compete for top honors on the wild(life)ly popular show.

But the Enquirer has learned that Fred has a checkered past. Long before moving to the U.S. in search of fame and fortune, he volunteered in the Antarctic Army. Our intrepid reporters have discovered that while he was posted to New Zealand, Fred became "involved" with Ginger, a Little Blue penguin he met there.

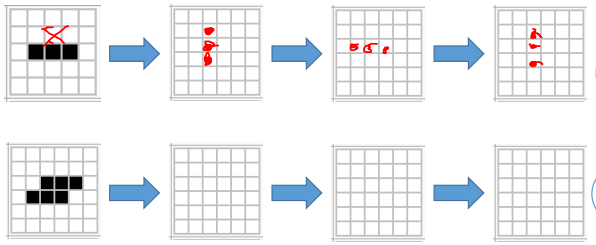
"He was such a great dancer," sobbed Ginger. "I thought he loved me. But when I laid an egg, he didn't even take care of it through the winter! He abandoned me! Oh, what's the use? He'll never come back!"





The Game of Life

1. Any live cell with fewer than two neighbors dies of loneliness.
2. Any live cell with more than three neighbors dies of overcrowding.
3. Any live cell with two or three neighbors lives, unchanged, to the next generation.
4. Any dead cell with exactly three neighbors comes to life.



The inventor did this by hand. It's a pain! You try! ☺

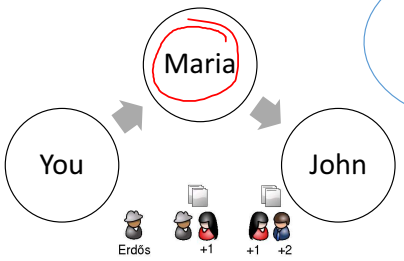
Never start coding before you can do "it" by hand!

John Conway's Game of Life

Wikipedia says that in college I'd play backgammon for hours in the common room

I'm pretty awesome at naming things. (e.g. I also invented "Phutball (short for Philosopher's Football)"

I bet you $50 that no pattern can grow indefinitely



John Conway

John Conway's Game of Life

Oscillators of varying periods

John Conway's Game of Life

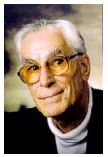
Gosper's Glider "Gun"

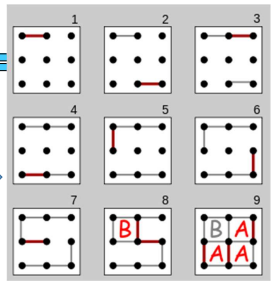
Life is "Universal" (1982)

Elwyn Berlekamp

John Conway

Richard Guy





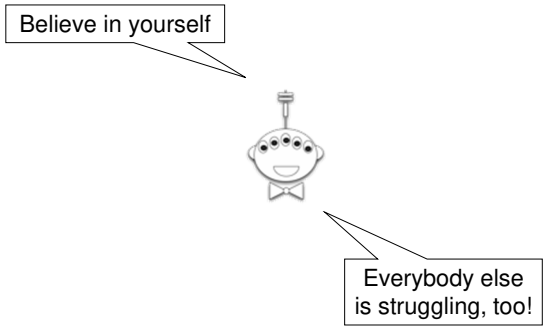
New stuff with the Game of Life

- "On May 18, 2010, Andrew J. Wade announced a self-constructing pattern dubbed Gemini which creates a copy of itself while destroying its parent. This pattern replicates in **34 million generations**"
- "Andrew J. Wade lives in Toronto, Ontario with his life partner. He has one child. He does no dishes and will do none for the foreseeable future."

2-D "Arrays"

```
>>> A = [ [0, 0, 0, 1], [1, 1, 0, 0], [0, 0, 0, 1] ]
>>> A = [ [0, 0, 0, 1],
          [1, 1, 0, 0],
          [0, 0, 0, 1] ]
>>> A[0][3]
???
```

The Alien's Life Advice



A RAID on Unreliability

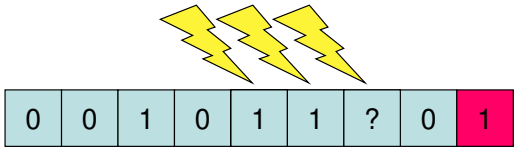
Hard drives are enormously reliable

- 1,000,000 hours before failure
  - == 114 years!
- Catch: must replace every 5 years…

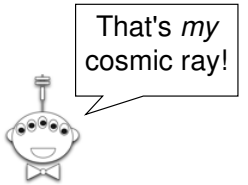
Amazon's problem: for every thousand drives, one failure every 1000 hours

Drive failure == data loss

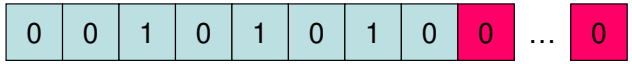
Digression: Error-Correcting Codes



Single-bit error *detection*



Digression: Error-Correcting Codes



Multiple-bit error *correction*

- Requires more than one error-check bit
- Generally detects more than it corrects
- See Math 171/172 for deep details

ECC

Error Correction on Hard Disks

Every **block** (512x8 = 4096 bits up to 4096x8 = 32768 bits) has error correction code (ECC) appended

- ECC is typically 300-800 bits
- Capable of correcting *burst error* of 100-600 bits

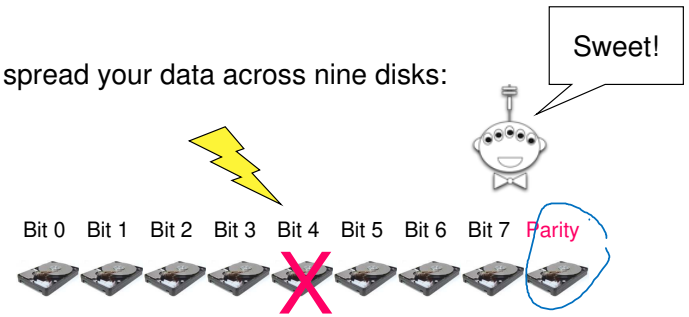
ECC can't fix a spindle-motor failure!

Redundant Arrays of In{expensive,dependent} Disks

RAID

Major insight: when a spindle fails, you know which one

Just spread your data across nine disks:



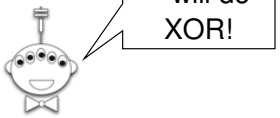
This is RAID-3, which for efficiency reasons isn't used in most real systems

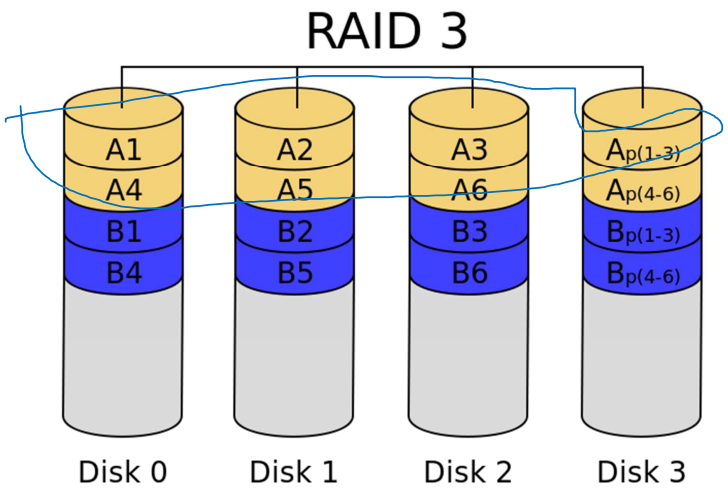
Worksheet: RAID Error Correction

dead

Write a function `correct(L, n)` that will correct the `n`th element of `L` to maintain even parity:

```
>>> correct([1, 0, 1, 1], 2)
[1, 0, 0, 1]
>>> correct([1, 0, 1, 0], 2)
[1, 0, 1, 0]
>>> correct([1, 0, 1, 1], 3)
[1, 0, 1, 0]
```



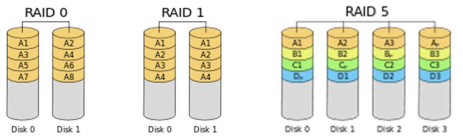


Modern RAID Levels

Original RAID paper defined five "levels" of redundancy

- No rhyme nor reason to numbering

Sixth level (RAID-0) added for performance without reliability



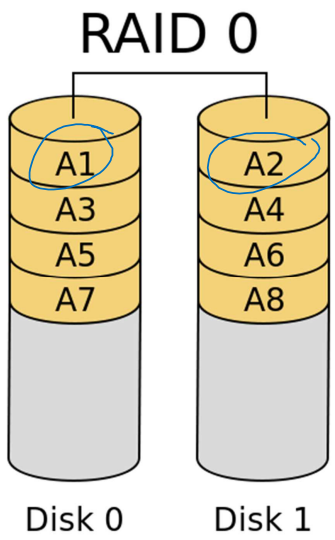
Levels used today:

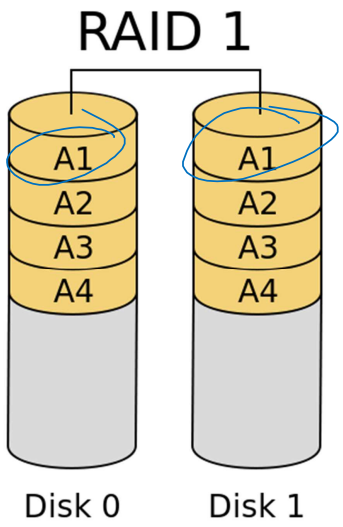
0: "Striping" for better performance

1: "Mirroring" on two disks in case one fails

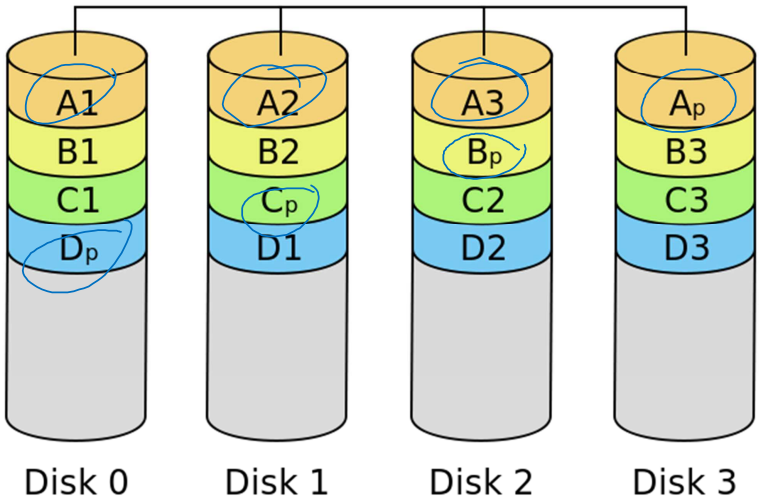
5: "Striped redundancy" recovers from one-disk failure

- When failure happens, reconstruct on new drive





RAID 5



The Dumb-Operator Problem

RAID-5 uses parity disk (cleverly optimized for better performance) to be able to recover from single-disk failure

Problem 1 (rare, but worrisome): it takes time to reconstruct disk after operator replaces it with a fresh one

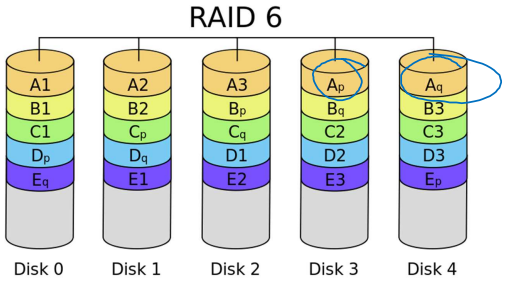
- Possibility of second drive failing during that time

RAID-6

Solution to the double-failure problem

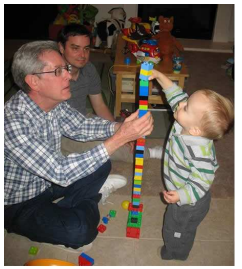
"Row diagonal parity" introduced by Network Appliance in 2004

Triple failures are rare enough to ignore (for most people)



Structured Query Language

```
mysql> select gpa from students where
        first_name = 'Donald' and
        last_name = 'Chamberlin' and
        grad_year = 1966;
+------+
| gpa  |
+------+
| 3.87 |
+------+
1 row in set (0.00 sec)
```



Don Chamberlin
HMC '66

The Power of SQL

```
mysql> select title, price from products
        where type = 'DVD' and genre = 'comedy'
        and title like 'The Hangover%'
        order by price descending; -- Highest price first

mysql> update products set price = price / 10
        where title = 'The Hangover Part II';

mysql> update users set password = 'secret', access = 'all'
        where username = 'geoff'; -- Give full access
```

SQL in Web Sites

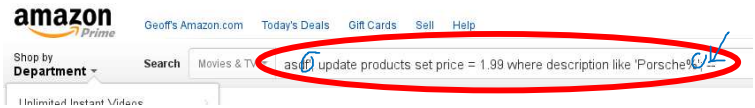
```
def lookupDVD(title_words):

        print "select title, price from products where type =
DVD and title like '" + title_words + "' order by price
ascending;"
```

SQL Injection

```
def lookupDVD(title_words):

        print "select title, price from products where type =
'DVD' and title like ' " + title_words + " ' order by price
ascending;"
```




```
select title, price from products where type = 'DVD' and title
like 'asdf'; update products set price = 1.99 where
description like 'Porsche%';-- ' order by price ascending;
```

SQL Injection

The Moral

NEVER trust input from a user!

Cookies

You've heard of how Web servers use cookies to remember things about you

Hey, that's *my* cookie!

Shopping cart idea: use cookie to remember what you ordered & its price…

The Moral

NEVER trust input from a user!

…even you think it originally came from you!