

Bar Codes

① History

Bernard Silver and N. Joseph Woodland played around with bar codes in the late 40s and have the first patent on bar codes from 1949.

The first application of bar codes was to label railway cars beginning in 1961 and rolled out substantially in the late 60s

This was never very effective because they got too dirty to read. Now RFID is used for this purpose.



The idea of bar codes for supermarket checkouts were discussed seriously as early as 1966. Testing in a store environment began in 1971, and the first commercial application was in 1974.

Codes made of vertical bars were chosen (over bullseye patterns and other possibilities) because if the paper slid in the printer they would merely elongate, remaining readable.

Bar codes in supermarkets are only cost effective if most (at least 70%) of products have the bar codes printed on them by the manufacturer. It was not clear until the 80s that this idea would take off.

Now there are bar codes everywhere.

There are many different standards. Let's discuss 2

- Interleaved 2 of 5 — a very old one rarely used today
- Code 39 — the first alphanumeric one

② Interleaved 2 of 5

We're trying to represent decimal digits with bars of different widths. How should we do this.

Note $\binom{5}{2} = 10$

So we could represent the digits with patterns of 5 bars 2 wide and 3 narrow

Benefits: ① All digits are represented by blocks of the same width
② Built-in error detector — if you misread a width you don't get a valid digit

How should we assign width patterns to digits

|||||

we're in the early 70s so don't want to use much computing power

Here is what is done

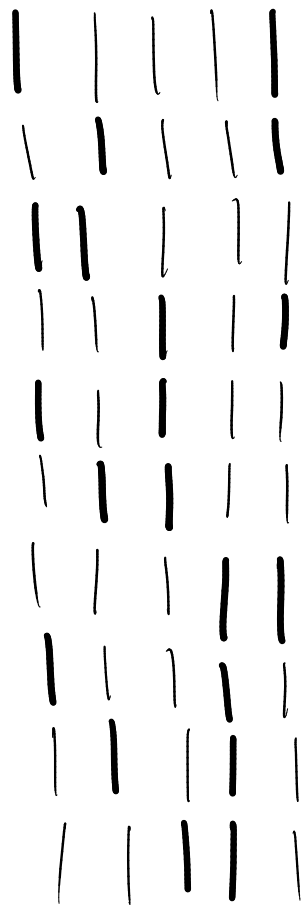
There are 5 bars.

Give them each a weight

Add the weights of the wide bars to get the number.

Weight

1 2 4 7 0



1

2

3

4

5

6

7

8

9

0 (11)

What about 0?

there's only one possibility left

So far this is just 2 of 5.

Plain 2 of 5 takes a lot of space — it is not very compact. How to do better?

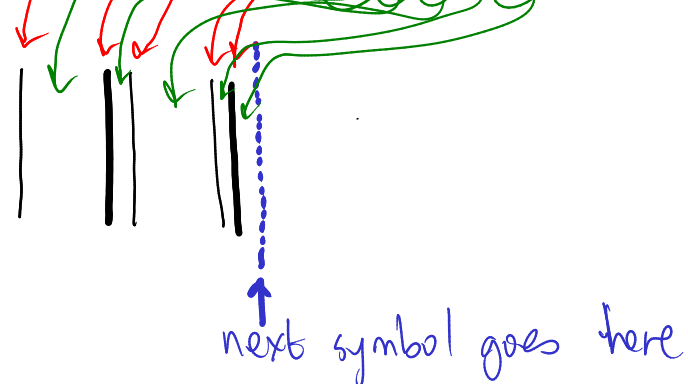
David Allais who was working for Intermec had the idea of taking pairs of digits and using a 2 of 5 encoding both on the bars and on the spaces (Intermec still exists and still makes bar code readers and printers)

This is interleaved 2 of 5

eg encode 25

2 encodes to nwnnw
5 encodes to wnwnn

n=narrow
w=wide



This brings up one additional problem — need to know how big the space is after the last line.

To do this have a special **stop code** || (wide bar, narrow space, narrow bar)

There is also a **start code** ||| (narrow bar, narrow space, narrow bar, narrow space)

Here's an eg

↑
next symbol begins here



③ Code 39

In 1974 at a meeting with representatives from Boeing. Allais promised something he didn't have - bar codes which could encode letters as well as numbers. With Ray Stevers he developed Code 39.

Each character is represented by a sequence of 5 bars and the four spaces between them. Two of the 5 bars are wide and one of the spaces is wide.

This gives

$$\binom{5}{2} \binom{4}{1} = 40$$

reserve one for a start and stop code that leaves 39 chars we can encode

Later they wanted a few more symbols so allowed some new patterns with 3 wide elements but not needed. 2 wide bars and 1 wide space

So modern code 39 has — . \$ / + % space
7 + 26 + 10 + stop

One can make a font for code 39

eg

math447

arethenotesposted

The only error detection is within the symbols

Newer barcode standards usually have check digits

④ Lets look at some examples

What bar codes can you find (say in your wallet)

For each bar code

how many different widths are used?

how wide is it given what is encoded?

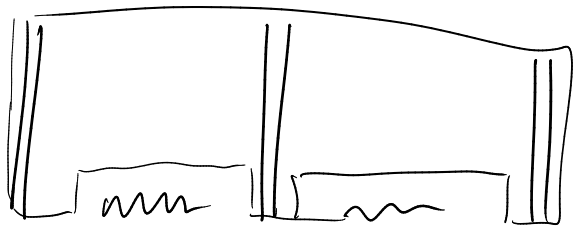
On your SFU ID there's a bar code for the library it is encoded with Codabar
any other library cards you have probably use codabar

2 widths

not very efficient

very common in libraries

More than one possible stop and start code



any line you see a code
with 4 possible widths
and which starts with

|| has || in the middle
and ends with ||

possibly in this shape (not necess.) you're looking at UPC

UPC is found on products also things like
grocery store rewards cards

On your BC drivers license there are two
bar codes one is a 1D bar code and one is
a 2D bar code

The 1D bar code is code 128 — it can represent
all ASCII characters

The 2D bar code is a stacked 2D code
ie it is a boat of 1D barcodes stacked
this is PDF417

In terms of coding theory PDF417 is a much more interesting bar code because it actually contains error correction.

We'll discuss 2D bar codes on Wednesday

Sources:

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http://en.wikipedia.org/wiki/Automatic_Car_Identification

http://en.wikipedia.org/wiki/Universal_Product_Code

<http://en.wikipedia.org/wiki/Codabar>

http://en.wikipedia.org/wiki/Interleaved_2_of_5

http://en.wikipedia.org/wiki/Code_39

http://en.wikipedia.org/wiki/Code_128