Braille Carries Digits Within Six Dots Not by Adding Shapes but by Switching Meaning With a Sign

— placing one number sign and letting digits borrow the shapes of a to j takes 47 and leaves 16 spare (9 shapes freed, 0.142857) — the separator is whether one adds shapes or switches meaning — [Paper 821]

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Abstract

A braille cell has only six dots.This paper counts why those 64 shapes carry letters, digits and punctuation: not the number of shapes but a sign that switches meaning.No new theorem or law is claimed. First, there are only 64 shapes——distributed as $1, 6, 15, 20, 15, 6, 1$ by number of dots, with 42 (0.656250) having three dots or fewer (Section 2). **Second, as information it is enough——4.700440 bits for 26 letters, 5.169925 for 36, 5.807355 for 56 , all inside 6 bits** (Section 2). **Third, and this is the core. Enough as information, yet almost nothing is left spare——assigning them separately among the 63 non-blank shapes takes 56 and leaves 7** (Section 3). **Fourth, one sign more than doubles the spare——letting digits borrow the shapes of a to j takes 47 and leaves 16, freeing 9 shapes (0.142857)** (Section 3). **Fifth, what grew is not the shapes but the meanings——the 64 shapes stay as they are while what can be written grows** (Section 4). **Sixth, the separator is whether one adds shapes or switches meaning——eight dots would give 256 shapes, but that is the other road** (Section 4). **Keywords**: braille, encoding, combinations, information, number sign, assignment.

> **Scope of this paper (scope note)**: **No new theorem or law is claimed——that six dots give 64 combinations, that digits are written with a number sign, and that eight-dot braille gives 256, are all known.No code is adjudicated——which braille system of which language is correct is not treated; where the sign sits differs between systems.No history is written——the invention and its adoption are not the subject.Readability is not treated——tactile resolution, dot spacing and reading speed are not included.Contractions are not entered——rules that shorten words are not treated.The numbers are examples——taking punctuation as 20 marks is a representative value for counting.Relation to earlier papers**: **Paper 163 showed that "a good code exists" and "here is a good code" are different sentences——this paper stands beside it: there existence against construction, here capacity against assignment.Paper 300 showed that whether two things share a root is decidable——"the number of shapes" and "the number of meanings" are distinct roots, and the sign sits between them.**What is added is **counting the shapes by number of dots**, **measuring the information needed from 4.700440 to 5.807355 bits against 6**, **counting the spare shapes as 7 under separate assignment and 16 with a sign**, and **placing the separator on adding shapes versus switching meaning**.

1. Notation and the Question

Setting: **a braille cell has six dots, each raised or not, giving $2^6 = 64$ shapes.Taking the all-flat shape as a blank leaves 63 for characters.**

Letters 26, digits 10 and punctuation 20 are to be carried.The information needed is measured by $\log_2$.

$$\log_2 26 = 4.700440, \qquad \log_2 36 = 5.169925, \qquad \log_2 56 = 5.807355$$

Question: **how are 56 kinds carried in a vessel of 6 bits?**

2. Counting the Shapes

Computation 2.1: **the shapes were counted by number of dots.**

dots	0	1	2	3	4	5	6
shapes	1	6	15	20	15	6	1

The total is 64, and 42 shapes (0.656250) have three dots or fewer.

Observation 2.2

as information it is enough.Letters alone need 4.700440 bits and everything together 5.807355, both inside 6 ——it is not that they do not fit.

3. Counting the Spare

Computation 3.1: **two assignments over the 63 shapes were counted.**

assignment	shapes needed	spare
letters 26, digits 10, punctuation 20 separately	56	7
digits borrow letters, with one sign	47	16

Observation 3.2

this is the core. Enough as information, yet almost nothing is left spare.Separate assignment leaves 7 shapes, 0.111111 of the 63——fitting and leaving room to extend are two different things.

Observation 3.3

one sign more than doubles the spare.Letting digits borrow the shapes of a to j takes 47 and leaves 16; 9 shapes are freed, 0.142857 of the 63——the sign itself uses one shape, so the gain is 9, not 10.

4. The Separator

Observation 4.1

what grew is not the shapes but the meanings.There are still 64 shapes; only what can be written has grown ——the same shape means one thing before the sign and another after it.

Observation 4.2

the separator is whether one adds shapes or switches meaning.Eight dots give 256 shapes and plenty of spare——but that means more dots under the finger, which is the other road.

Observation 4.3

placed beside Papers 163 and 300.Paper 163 showed that “a good code exists” and “here is a good code” are different sentences——here “six bits suffice” and “the 63 shapes can be assigned” are different sentences.Paper 300 showed that sharing a root is decidable——the number of shapes and the number of meanings are distinct roots.

Observation 4.4

what is not said.National codes, history, readability and contraction rules are not treated——what is shown is that a sign grows the meanings without growing the shapes.

5. Census and Closing

1. **64 shapes** (Computation 2.1): **including the blank.**
2. **1, 6, 15, 20, 15, 6, 1 by dots** (Computation 2.1): **binomial coefficients.**
3. **42 with three or fewer (0.656250)** (Computation 2.1): **more than half.**
4. **letters need 4.700440 bits** (Section 2): **inside 6.**
5. **everything needs 5.807355 bits** (Section 2): **still inside.**
6. **separate assignment leaves 7** (Computation 3.1): **the core; no room.**
7. **with a sign it leaves 16** (Computation 3.1): **more than double.**
8. **9 shapes freed (0.142857)** (Observation 3.3): **the sign costs one.**
9. **eight dots give 256** (Observation 4.2): **the road of more shapes.**
10. **shapes or meanings** (Observation 4.2): **the separator; Papers 163, 300.**

Closing: **Braille carries digits within six dots not by adding shapes but by switching meaning with a sign.Six dots give 64 shapes (1, 6, 15, 20, 15, 6, 1 by number of dots, 42 with three or fewer), and the information needed reaches only 5.807355 bits, inside 6——it is not that they do not fit.Yet assigning letters, digits and punctuation separately**

among the 63 non-blank shapes takes 56 and leaves only 7 spare, while one number sign with digits borrowing a to j takes 47 and leaves 16——9 shapes are freed, because the sign itself uses one.What grew is not the shapes but the meanings, and the separator is whether one adds shapes or switches meaning.Placed among the earlier papers——standing beside Paper 163's "exists" against "here it is", and keeping Paper 300's discipline between shapes and meanings.To be honest——taking punctuation as 20 marks is a representative value, and neither national codes nor readability is treated.

References

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